1998

# Engine room simulator for marine engineering cadets in Polyteknik Ungku Omar (PUO), Malaysia

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# ENGINE ROOM SIMULATOR FOR MARINE ENGINEERING CADETS IN POLITEKNIK UNGKU OMAR (PUO), MALAYSIA

By

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A dissertation submitted to the World Maritime University in partial fulfilment of the requirements for the award of the degree of

MASTER OF SCIENCE

in

MARITIME EDUCATION AND TRAINING
(Engineering)

1998

# DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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## DEDICATION

*Dedicated to my wife,* ***Ming Sew***

*and*

*my children,* ***Cia Yin, Cia Ching, Cia Pey.***

# ACKNOWLEDGEMENTS

I wish to express my sincere gratitude to Professor Takeshi Nakazawa, my supervisor for his untiring guidance and contributions in preparing this dissertation.

Gratefulness is also extended to: Professor Peter Muirhead, (Maritime Education and Training Course professor); Professor Takashi Nakamura from Marine Technical College, Japan; and Mr. Stephen Stallwood from Southampton Institute, UK; for their effective guidance in the success of this dissertation.

Special thanks to: the Global Foundation for Research and Scholarship, Japan; World Maritime University (WMU), Sweden; Politeknik Ungku Omar, Malaysia; and Public Service Department, Malaysia; for the generous scholarship and funding that made it possible for me to study in this renowned University.

My special thanks to all the professors, visiting professors and teaching staff of WMU for imparting invaluable knowledge. Gratitude is also extended to the WMU library staff for their willingness and tireless efforts in providing information and assistance.

To my late mother and father, may their souls rest in eternal peace.

Finally, I would like to dedicate this paper to my loving wife (Ming Sew), son (Cia Ching) and daughters (Cia Yin and Cia Pey), who have provided the support and inspiration for the successful completion of this dissertation.

# ABSTRACT

Title of Dissertation: **Engine Room Simulator for Marine Engineering Cadets in Politeknik Ungku Omar (PUO), Malaysia.**

Degree: **MSc.**

This dissertation examines the potential use of the Engine Room Simulator as a new training aid for Marine Engineering Cadets at Politeknik Ungku Omar, Malaysia as well as within the country's Maritime Education and Training (MET) system. The main reason to introduce Engine Room Simulator as a new training aid is to overcome some of the problems of cadet training onboard high technology ships today.

The impact of modern technology on the shipping industry has resulted in the existence of high technology ships of the present day and also modern training equipment like the Engine Room Simulator. The value of simulation systems as a training tool was recognised by Maritime Education and Training institutions long time ago. Now, the STCW95 Convention and Codes has officially promoted the use of simulators to enhance training. The high technology ship with advanced machinery and automation systems has changed the role of engineering personnel onboard ship, therefore, this has affected shipboard training. As such, the formal education and training in MET institutions should be prepared to cope with the changes of training onboard. Some explanations on high technology ships with advanced machinery and automation system are given.

Various types of Engine Room Simulators and their use by the maritime simulator community is discussed and the existing weaknesses of the Marine

Engineering Diploma Course are identified. The use of a full-task/mission operational Engine Room Simulator is recommended. Therefore, engine room simulator programmes are proposed and incorporated in Semester 5 and 6 of the Marine Engineering Diploma Course (MEDC), which will further a provide better prospect for the MEDC. Finally, the author concludes that the consequences of the MEDC merely producing machinery operators who have insufficient academic knowledge and skill would be avoided. The author recommends this study to be taken up by a project team to be implemented appropriately with the use of a project plan.

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| | |
|---|---|
| ACB | Air Circuit Breaker. |
| ALAM | Akademi Laut Malaysia (Maritime Academy of Malaysia). |
| COC | Certificate of Competency. |
| ERS | Engine Room Simulator. |
| ERS1 | Pre-sea Engineering Cadet Engine Room Simulator Programme. |
| ERS2 | Post-sea Engineering Cadet Engine Room Simulator Programme. |
| ERS3 | Junior Engineer Officer Engine Room Simulator Programme. |
| HFO | Heavy Fuel Oil. |
| ISM | International Safety Management. |
| JICA | Japan International Co-operation Agency. |
| LAN | Local Area Network. |
| LNG | Liquefied Natural Gas. |
| LPG | Liquefied Petroleum Gas. |
| MARPOL | International Convention for the Prevention of Pollution from Ships. |
| MDO | Marine Diesel Oil. |
| MED | Marine Engineering Department. |
| MEDC | Marine Engineering Diploma Course. |
| MES | Mitsui Engineering & Shipbuilding Co., Ltd., Japan. |
| MET | Maritime Education and Training. |
| MOT | Ministry of Transport. |
| PUO | Politeknik Ungku Omar (Ungku Omar Polytechnic). |
| SOLAS | International Convention for the Safety of Life at Sea. |
| STCW Code | Seafarer's Training, Certification and Watchkeeping Code. |
| STCW78 | International Convention on Standard of Training, Certification and Watchkeeping for Seafarers, 1978. |

| | |
|---|---|
| STCW95 | International Convention on Standard of Training, Certification and Watchkeeping for Seafarers, 1978, as amended in 1995. |
| STW | Sub-committee on Standards of Training and Watchkeeping. |
| TEU | Twenty Equivalent Unit. |
| UMS | Unattended Machinery Space. |

# CHAPTER 1
# INTRODUCTION.

## 1.1 BACKGROUND OF THE STUDY.

Maritime education and training (MET) systems all over the world are rapidly changing due to the impact of modern technology. Advanced countries have explored, tried and tested various new methods to ensure efficient education and training of their seafarers, the results of which could provide beneficial guidelines on the approach for developing nations. One efficient and popular training method is to use simulators to enhance maritime education and training.

Malaysia is a developing nation that is at the cross-roads of change. In order to train local seafarers to man the Malaysian fleet, various maritime courses have been developed in Malaysia. Politeknik Ungku Omar (PUO) is the first institution providing formal education and training for marine engineering cadets in Malaysia. The course of study has continuously gained up to date revision and improvement in the theoretical academic curriculum. Unfortunately, due to the impact of modern technology onboard merchant ships today, some skill-based operational types of training onboard have to be shifted to the institution ashore. This situation exists mainly because of UMS ship operations which have reduced the operational experience on engine room watchkeeping and also the busy sailing schedule of the merchant ships today with reduced of manpower. Therefore, it is unable to provide good training for engineering cadets anymore onboard merchant ships. Thus, this results in the need for a compromise training ashore using a full-task/mission operational engine room simulator (ERS) for the operational training, which is now well established.

## 1.2 AIM OF THE STUDY.

The main aim of the study is to examine the potential use of the engine room simulator as a training aid for the Marine Engineering Diploma Course (MEDC) at PUO, with the intention to acquire an ERS in the near future.

In order to achieve the main aim the following should be considered:

1. To examine and evaluate the impact of modern shipboard technology on marine engineer training needs.
2. To survey current ERS technology and approaches taken by the international MET community in its use.
3. To identify the existing weakness of MEDC in PUO.
4. To consider the development of new simulation-based training programmes that could be conducted for the MEDC at PUO.
5. To make recommendations for the restructuring of the curriculum for the prospect of MEDC at PUO.

## 1.3 THE EDUCATION AND TRAINING OF MARINE ENGINEERS IN MALAYSIA.

In Malaysia, there are three institutions conducting marine engineering education and training. They are namely, the Politeknik Ungku Omar (PUO), the

Akademi Laut Malaysia (ALAM) and the Universiti Teknologi Malaysia (UTM). Students from upper secondary schools who have completed eleven years of general education are eligible for enrolment at any of these three institutions.

Since 1972, PUO has been offering the Marine Engineering Diploma Course (MEDC) for engineering cadets. It is a pioneer institution which produces most of the marine engineer officers at operational level in Malaysia. The MEDC, course duration was six years which included waiting periods for sign on and sign off of ships. Since 1985, the course duration has been reduced to four years. The duration of the course has been shortened by a reduction in sea training time from 18 months to 12 months, proper co-ordination of sea training without sacrificing much of the waiting period and compacting the course curriculum.

Upon completion of the course, students are eligible to serve onboard merchant ships as engineer officer after passing the Fourth Class COC oral examination which is conducted under MOT. Therefore, this course is specially caters for the producing of shipboard engineer officers to man Malaysian ships. Further upgrading courses, examinations and additional sea-time are needed to enable engineer officers to achieve Second Class and First Class COC, in order to allow them to serve as second and chief engineer officers respectively onboard merchant ships. Unfortunately, these upgrading courses were not available in Malaysia until 1983. Consequently, during that period of time before 1983, the engineer officers had to go overseas to pursue those upgrading courses.

In 1981, ALAM was established. Those upgrading courses for engineer officers mentioned earlier have been offered by ALAM since 1983. In order to overcome the shortage of marine engineers in Malaysia, ALAM started conducting a four year Marine Engineering Diploma Course in 1992. The course is similar to that offered by PUO.

Since 1983, UTM has conducted a Marine Technology Course at the level of Bachelor Degree and Diploma for the duration of five years and three years respectively. The main aim of UTM is to supply marine technologists for the shore based maritime industry. However, the graduates from both levels also can serve as engineer officers onboard merchant ship after acquiring 12 months approved sea service experience as assistant engineer officers (cadets).

# CHAPTER 2

# THE IMPACT OF MODERN TECHNOLOGY ON MARINE ENGINEER TRAINING.

## 2.1. MODERN TECHNOLOGY IN SHIPPING AND THE HIGH TECHNOLOGY SHIP.

Modern technology has influenced greatly engineering design and the operation of ships since the last recession and oil crisis in the 1970's. Sophisticated electronic equipment, as well as computers, have been introduced in the shipping industry. Modern technology has resulted in the existence of high technology ships of the present and future such as Unattended Machinery Space (UMS) Ship and Unmanned Ship respectively. For UMS ship operation, the man-machine interface capabilities at the wheel-house and engine control room enable the machinery spaces in the engine room to be left unattended. Advanced countries like Japan, Sweden and Germany have the technical know-how and financial capability to lead the research and development continuously for the optimisation of ship operation and competitiveness. The following are the main areas of developments due to modern technology.

### 2.1.1 MAIN PROPULSION SYSTEMS.

From the annual analysis conducted by Doughty (1997, 44-45), the two-stroke slow speed diesel engine is proven to be the most popular type of prime mover being used nowadays in the main propulsion of merchant ships. Steam turbines, gas turbines and other types of diesel engine of course have other specialised applications but have not been able to upset the dominance of the two-stroke slow speed diesel engine in this area.

Rapid development and continuous research is being carried out for the two-stroke slow speed diesel engine by engine makers. The overall ship propulsive efficiency has always been a great concern to the shipowner as well as the shipbuilder. The oil crisis in the 1970's, which created a drastic increase in fuel oil prices, has constrained engine builders to focus their attention and efforts to develop an engine having a low fuel oil consumption, whilst the naval architects were engaged in research to improve hull and propeller design (Spyrou, 1988, 64-69).

In 1975 the specific fuel oil consumption for a long-stroke slow speed diesel engine was 214 g/kWh, which at the time was giving an engine thermal efficiency of approximately 40 %. By the end of 1985, research had managed to reduce this figure down to a record value of 153 g/kWh for an engine thermal efficiency of about 52 %. A Stroke to bore ratio of up to 4.2 is being used, hence this has resulted in higher combustion pressures and lower engine speed. The higher combustion pressures phenomenon improves combustion capability, thereby, resulting in higher engine efficiency and permitting the use of very low quality (cheaper and heavier) marine fuel oil. As regard the lower engine speed, this has enabled the use of the larger pitch higher efficiency propeller. The maximum pressure in the cylinder has remarkably increased from about 80 bar to 160 bar. This will require stronger materials to build the engine and special technical know-how to operate and maintain it. (Listewnik, 1997*b*)

With special design and special manufacturing features of the slow speed diesel engine, the maintenance interval between major overhauls has achieved 14,000 running hours (Barrow, 1995, 2). However, this could soon be increased significantly to about 25,000 running hours.

Continuous research and development will definitely result in the production of a more reliable, maintenance friendly and economical series of two-stroke slow speed diesel engines for the main propulsion plants of the future.

## AUTOMATION WITH CONDITION MONITORING AND REMOTE CONTROL SYSTEMS FOR MAIN PROPULSION.

The modern diesel engine for main propulsion needs to be continuously monitored and controlled in its optimum operating parameters for the benefit of maximum engine efficiency together with safe and reliable engine performance. This type of precise monitoring and controlling is not possible to be performed manually by the ordinary five senses of the human being anymore. Fortunately, with the great invention of automation, this type of task can be easily performed precisely and reliably by modern equipment. Therefore, the modern diesel engine propulsion plant is required to have automation with condition monitoring and remote control systems. In line with modern technology, the automation with condition monitoring and remote control systems have gained tremendous improvements over the years.

### CONDITION MONITORING SYSTEMS.

Presently, the more reliable and successful main propulsion diesel engine condition monitoring systems are liner temperature condition, top piston ring condition and cylinder pressure monitoring systems (Listewnik, 1997*b*).

The liner temperature condition monitoring system utilises temperature sensors fitted in the liner. The sensor detects piston ring temperature and normalises the condition to the liner temperature. Therefore, the corresponding piston ring temperature could be estimated through the detected liner temperature. The system is especially useful when sensing liner temperature under varying engine load operation such as manoeuvring or heavy sea running conditions. The data obtained should be compared to the same engine load condition as recommended by the engine maker.

The top piston ring condition monitoring system provides an effective and reliable method of monitoring the top piston ring condition during engine operation. This system uses a high speed inductive sensor fitted above the scavenge ports. A special helical bronze alloy insert is fitted to the top ring circumferentially for the purpose of determining the top ring wear pattern. The top ring is a preprofile ring of deeper height. The system also enable a graphical display of the wear pattern on a personal computer monitor with print out capability. Hence, efficient monitoring of the critical top piston ring can always be carried out. This system is known as the Sulzer Integrated Piston-ring Wear-detecting Arrangement, as defined by Aeberli and Bitterli (1995, 15-17).

The cylinder pressure monitoring system is equipped with an electronic indicator to monitor the cylinder pressure by taking an indicator diagram of the respective cylinder. The device could be a portable set or incorporated along with the indicator cock fitting of the cylinder cover.

The diesel engine condition monitoring systems still need a lot of research and development in areas of reliability and stability of their electronic components such as sensors and transducers. These are the important criteria for accurate data processing since any malfunction of the electronic component under heavy engine load operation could result in detrimental consequences to the monitoring system.

Improvement on the instrumentation of the monitoring system is also an area to look into in view of the harsh condition this instrumentation experiences during engine operation.

The decentralisation of the diesel engine monitoring system is the trend of the present development. This will ensure that the individual engine component monitoring system functions independently without relying on the central monitoring unit. This method will reduce unnecessary error or input data from other variables due to the load of data processing in a central monitoring system. However, if the need arises, the data collected from the individual monitoring system could be fed into the central monitoring unit for comparing the overall engine performance (Listewnik, 1997*b*).

It is the author's view that the diesel engine condition monitoring system is a good way of determining the period of overhaul of the cylinder unit or defective component before a major breakdown. The engineers must be knowledgeable in the area of automation and control in order to appreciate the capability of the system. With the trend of reduced manning and the competitive shipping market economy these days, the diesel engine conditioning monitoring system is indeed an asset for the shipowner.

## REMOTE CONTROL SYSTEMS

Remote control systems for main propulsion is a prerequisite for UMS ship operation. The data collected from all the monitoring systems are sent to both the wheel-house and the engine control room, through an interface of digital or analogue inputs and outputs to microprocessors or computers where the signals are being processed. The incorporated programmes in the remote control systems shall be able to start, stop, reverse, run-up, run-down and emergency stop/run the diesel engine precisely (Rickert, 1997).

Currently, the remote control systems have already improved to a very advance level. According to the author, among some of the advantages of these remote control systems are efficient manoeuvrability, low engine fuel consumption and low starting air consumption.

### 2.1.2 AUXILIARY SYSTEMS.

The electrical power generation system is one of the most essential systems onboard a ship. The system consists of engines of various types. The electric generator may be driven by a medium speed diesel engine, a steam turbine, a gas turbine or the main propulsion low speed diesel engine.

The medium speed diesel engine may run on either of the following fuels;

i. Marine Diesel Oil (MDO),
ii. Heavy Fuel Oil (HFO),
iii. Blended Oil consisting of blend between MDO and HFO.

Steam turbines may acquire the steam from steam boilers or waste heat recovery systems (Economiser).

Gas turbines may operate on high speed diesel fuel oil or other less dense fuels, due to the fact that less dense fuels being used there will be a higher risk towards fire and explosion, besides the high cost of the fuels. Therefore, gas turbines are not popular in merchant ships except in LPG or LNG carriers where the fuels are available from relieved off facilities.

The main propulsion low speed diesel engine which has a sophisticated arrangement of shaft electric generator is now widely used. This is the modern trend of today's electrical power generation due to the fact that almost all main propulsion low speed diesel engines burn very low quality HFO, but with a much higher efficiency as compared to the medium-speed diesel engine electric generator using the same type of fuel. Moreover, the medium-speed diesel engine electric generator nowadays does not prefer to run on HFO anymore because too much care and maintenance is required.

As a prerequisite for UMS ship operation, the electric generators should be capable of automatic cut-in/cut-out to/from the main bus-bar, depending on the amount of electric load required at times. Alternatively, the electric generators also can be cut-in or cut-out at will, by manually pushing the corresponding start or stop button. However, the author feels that the traditional method of starting up the electric generator engine followed by synchronisation with the main bus-bar parameters before switching on the air circuit breaker (ACB) manually should be made possible, in case those automatic systems fail.

All other auxiliary systems like bilge system, fire detecting and fighting systems, fuel transferring system and steering gear system shall comply with the stringent requirements of International Conventions like SOLAS 73/78 and MARPOL 73/78. In general, reliability and maintainability of auxiliary systems are of utmost importance. The economical aspect of auxiliary systems is to be considered only if its safety aspect is fulfilled.

MONITORING OF AUXILIARY SYSTEMS.

The monitoring of auxiliary systems onboard a modern ship normally can accept digital and analogue signals, as many as 672 digital and 100 analogue channels. All the alarm limit settings can be changed at will. Any activated alarms and faults can be printed and recorded whenever needed. Regular interval automatic logging of all manoeuvring signals has relieved the engineer from this routine task. (Ricket, 1997)

Similar to the main propulsion system, according to the author, auxiliary systems also have the same problems in the areas of reliability and stability of its electronic components, such as the sensor and transducer; for example, combustion chamber sensors which have to withstand extreme temperatures and pressures. In addition, the monitoring systems are under electromagnetic compatibility and interference. This phenomenon will affect the accuracy of the control signals. Therefore, there is still room for improvement in this area.

## 2.2 THE CHANGED ROLE OF MARINE ENGINEER AFFECTED TRAINING.

In the old days, the marine engineers had to operate the machinery manually due to the fact that most of the monitoring and control systems were basically of a pneumatic, hydraulic or mechanical type without integration to any microprocessor. As such, very limited automation is possible. Moreover, steam ships with coal fired boilers were dominant in those days. Therefore, a large amount of manpower was required to keep engine room watches. For example, a large passenger steam ship like the Titanic needed eight engineers including an electrical engineer on each engine room watch to supervise the firemen, greasers and coal trimmers. In addition, there were another seven engineers with individual specialisation, including the Chief engineer, who were on day work. Therefore, there were all together thirty one engineer officers onboard. The nature of the engineer's job was much tougher in those days. 'Need not to be mentioned, marine engineers should understand.' They are the great people in the Titanic (Griffiphs, 1998).

Nowadays, in UMS ship operation, machinery faults have to be diagnosed by analysing two sets of printed data and decide whether they are normal or not. Marine engineers have to take care of automation systems onboard ship by doing instrument maintenance in the day time. The machinery space is left operated unmanned during the night time. Therefore, constant engine room watchkeeping by an engineer is not needed anymore. As such, there will be a reduction of engineer experience on engine room watchkeeping. Correspondingly, cadets watchkeeping experience during their apprenticeship onboard will also significantly be reduced. This disturbing situation can greatly affect the safety of a ship if it is going to sail on the non UMS ship type which requires their five senses skill to analyse normal and abnormal conditions. The situation also exists where marine engineer experience on major shipboard preventive maintenance and major emergency repair is also remarkably being reduced due to the fact that the task is already taken over by the shore team. Thus, the role of the marine engineer on job training has been affected. Therefore, a mean of compromised training is absolutely required since the present ships consist of various classes of technological level.

Currently, in most developing countries, it is obvious that the trend of changing from manned to unmanned machinery spaces is still in transition. However, there are still many old ships with manned machinery spaces which have remained for trading. In addition, there are ship operators still continuously acquiring second-hand UMS ships from the advanced countries and have converted those ships into non UMS ships. The reasons might be the lower cost of labour available as compared to high initial cost of repair for automation and control systems and/or lack of seafarers with sufficient technical know-how to maintain UMS ship operation. As such, marine engineers should learn to work with both UMS and non UMS ships. In order to reduce the burden of the marine engineer, the best solution is to train various categories of marine engineers to handle respective technological levels of ships. Unfortunately, this solution may not be cost effective for ship operators in the advanced countries.

The same situation also exists in Malaysia, where many new ships acquired by shipping companies have also incorporated modern equipment found today and yet many old ships have remained. Consequently, a wider range of education and training is indeed needed for engineers, especially for the cadets who will sail on both conventional and modern types of ships tomorrow.

## 2.3 IMPACT ON FORMAL EDUCATION AND TRAINING OF MARINE ENGINEERS.

The new demands of technology have necessitated that MET institutions work closely with shipping companies, and along with the Marine Administration of respective countries, safeguard all activities falling within the national and international regulations. MET institutions should evolve new courses to better cater to the needs of industry in their respective countries. Maritime education and training constantly needs attention and scrutiny.

The curriculum of control engineering, basic and applied electronics, microprocessors, computers, information technology and competency based training, should undergo major modifications and improvements.

The teaching staff need to be dedicated to their professions. They should educate and equip their students with the appropriate level of knowledge and technical know-how. On the other hand, students should reciprocate their knowledge, share experiences among themselves and be thankful to their teachers. In order to avoid disasters happening, it is worthy to have the saying, "Some unfortunate people have to learn from mistakes but a lucky person should be thankful to learn from people's experience." As such, the line between students and teachers should be diminished in order to foster a more conducive teaching and learning environment.

Teaching and learning facilities like lecture rooms, laboratories, workshops and teaching aids also require some attention. For instance, a workshop of the marine power plant needs a certain appropriate level of automation and control in order to suit the training method of the existing ships. In order to reinforce the learning process, a class lecture could have various forms of audio-visual aids like overhead projector, slide projector, cine projector and video equipment instead of just a blackboard and chalk with talk. The ship engine room simulator is also considered one of the important modern tools to immediately affect high technology ship training at MET institutions. Therefore, it is now seen to be necessary to be acquired by MET institutions due to the impact of high technology.

Realisation of the impact of modern technology on MET institutions is a good sign towards further development and improvement of the institutions. Therefore, MET institutions should be prepared to cope with the new challenge all the time.

## 2.4 IMPACT ON CREW AND MANNING LEVELS.

Modern technology has increased the level of automation onboard. Many tasks which were performed by manpower have already been taken over by modern equipment. Therefore, only a minimum amount of manpower is required to take care of the automation systems.

For UMS ship operation, engineers do not have to maintain constant engine room watchkeeping anymore. They just have to be on the day work doing some instrument maintenance besides comparing/analysing the printed machinery operating parameters. As such, the number of engineers and engine crew could be reduced. In addition, the general trend for UMS ship operation in the developed world has dual certificated officers who are capable of keeping both navigational and engine room watches at the wheel-house with the assistance of a dual purpose crew for each watch.

With the improved satellite communication system onboard, radio officers seem to have lost their main role. However, they may change their roles to become experts who are responsible for electronic equipment maintenance. Due to the reduced number of people onboard, catering matters could be taken care of by only one well trained person.

For the cost effective reasons of reducing manning onboard major shipboard preventive and major emergency breakdown repairs are not being able to be done by the ship's crews alone. Instead, shore team support is needed. Unfortunately, this will reduce the ship crew's on the job training experience.

The modern trend of shipboard organisation has merged Engine and Deck Departments. The junior officers and crews are dual certificated. However, the senior officers still maintain their specialisation as an engineer or a deck officer.

Eventually, when the dual certificated officers have achieved their senior ranks in the near future, there will be a possibility of reducing manning further at that senior level. Obviously, the role of radio officer has diminished and catering matters can be self reliance. As a result, the modern trend with a crew of seven persons onboard a typical, high technology ship, is possible (Spyrou, 1988, 76-78). This includes the Master as ship manager (commander), three dual certificated officers as watchkeepers and three dual purpose crew as assistant watchkeepers.

## 2.5 ENGINE ROOM SIMULATOR TO ENHANCE THE TRAINING OF MARINE ENGINEERS.

Modern technology has raised the level of automation and machinery design sophistication onboard modern ships. In addition, modern technology capable to easily produce a dynamic real-time computerised simulator that can compress years of experience into a few weeks, as quoted by many operators and makers of simulators.

Even though the best way to gain practical experience is to learn from real life in a real engine room, if any error is made, it may result in a catastrophe that can endanger life, environment and property. Today, the engine room simulator capable of simulating a realistic engine room environment, gives the operator first hand experience of the dynamic real-time response of engine room systems. Moreover, the operator can gain self-confidence through practising various types of operation, including those operations that cannot be done on a real engine. Hence, class room studies, workshop practice and training onboard ship, which are still a common method of MET in many developing countries, should be enhanced with engine room simulator training.

# CHAPTER 3

# SIMULATORS FOR MARINE ENGINEERS EDUCATION AND TRAINING.

## 3.1 INTRODUCTION.

In the past many major accidents occurred at sea primarily due to the operational errors of man and secondarily due to machinery technical failures. Consequently, these primary and secondary reasons have resulted in the intervention of simulators for marine engineer education and training, and high technology ships with improved machinery engineering design respectively. In addition, for economical reasons the high technology ship, since the 1970's, has increased the level of automation in the engine room in order to reduce manning by the introduction of periodically unattended machinery spaces type of ship.

The reduction of manning has resulted in major maintenance onboard being done with shore support. Obviously, marine engineers will have added responsibility concerning instrumentation preventive maintenance along with a significant reduction of experience in both engine operation and major maintenance on-the-job-training onboard. Therefore, in order not to compromise the engineer's experience for optimum and safe operation of a complex propulsion plant, probably the best solution is to use a dynamic real-time computerised engine room simulator for operational training, which is now well established, thus, enabling the boosting up of the confidence of the engineers.

One of the earliest concepts of simulation was first applied in the field of aeronautics in order to minimise human error for achieving 'zero defect' and hopefully no chance for an accident to occur. However, in the shipping industry, simulation is to facilitate learning in the real ship environment by prior learning the same task in a simulated situation. Therefore, the demand of accuracy for simulation in the shipping industry could be made less stringent. Consequently, marine engineers should also realise certain weaknesses in engine room simulators.

According to Professor Toshio Hikima, a visiting professor from the Marine Technical College, Japan, who was interviewed by the author in 1998, the future simulators will have a very different operational manner. The present simulators need the physical operation of push-buttons, switches, control levers, etc. However, in the future simulators will only need the human voice for the command/operation of engines/machinery. This is due to the fact that, since September, 1997, there is already an existing LPG carrier M.V. Shin-Propane Maru using human voices to control the engine/machinery operations.

As such, according to him, probably simulators of the future need to be adapted with such an advanced function. This implies that future simulators for marine engineers education and training will be constantly changing as rapidly as the advancement of technology used for merchant ships. As such a typical simulator for marine engineer education and training is not an everlasting training device to be used. Consequently, the period of level of technology that will last/remain in the shipping industry could be one of the deciding factors for the estimation of the simulator's cost depreciation. However, the cost effectiveness of using simulators varies from country to country and also depends on the country's economic situation from time to time. Thus, it is quite impossible to judge the cost effectiveness of using simulators accurately. Therefore, it is a much more complex matter internationally.

## 3.2. TYPES OF SIMULATOR FOR EQUIPMENT, MACHINERY AND SYSTEM TRAINING IN THE MACHINERY SPACES.

There are many ways to classify simulators for propulsion systems. The simulator may be generic, that does not represent any specific equipment or system, like procedures, knowledge and rule-based trainers. The simulator may also be a replica that may operate in real or regulated time, like a part task simulator for a particular engine room system and an operational full task/mission engine room simulator. However, for ease of explanation the existing types of simulator for equipment, machinery and system training in the machinery spaces today could be classified under the following types.

### 3.2.1 "COMPUTER BASED TRAINING (CBT) SIMULATOR".

The definition for a CBT Simulator is given in the STW sub-committee, agenda item 3 on the 25th session (STW/25/3/7, 1993) report as:

> Programmes designed to simulate a single ship's system or set of operations in real time for interactive use by an individual.

The CBT Simulator consists of a hardware personal computer with system requirements and a simulation software package. The simulation software simulates a ship engine room system including main engine, boilers, fuel oil system, cooling water system and electrical power distribution system. However, only one engine room system is able to be used each time for basic level training. The CBT Simulator is able to perform normal operations, trouble-shooting, watchkeeping and emergency operation scenarios. With the multimedia techniques such as audio, video and animation, computer based training simulation is made more real.

Development of CBT Simulator software by simulator makers is not very encouraging because the software could be easily written, copied and become outdated. Such a phenomenon results in impression of doubt towards the standards not meeting requirements. Moreover, the profit margin is low and the simulator display operated by keyboard is also lacks realism. However, CBT Simulators have the merit of low cost, a high trainee to instructor ratio, or even without the presence of an instructor, and trainees could work independently and have an effective dialogue with the simulator for problem solving. The low cost of the CBT Simulator is evidenced, for an example the Seagull AS is a CBT Simulator supplier in Norway which sells a software programme of fuel oil system, or any other engine system, at a cost of only 2000 Norwegian Kroner.

### 3.2.2 "WORKSTATION VERSION SIMULATOR".

A Workstation Version Simulator consists of a number of colourgraphic high memory and high speed central processing units (CPU) / computers. The computers are connected together through an ethernet Local Area Network (LAN). The main component in the simulator configuration is the instructor workstation that acts as a server for all other workstations. The software models are implemented in the instructor workstation and eventually distributed to other workstations. Multiple instructor workstations can be connected to the same ethernet (LAN) for more flexible training which enables different software models to run in parallel.

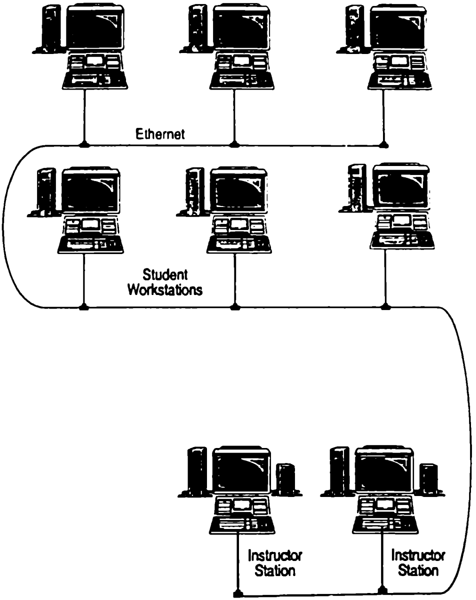


**Figure 3.1: Typical Configuration of a Workstation Version Simulator.**

**Source: Propulsion Plant Training (PPT 2000) Manual, Norcontrol.**

A typical Workstation Version Simulator configuration is as shown in Figure 3.1. These workstations shall operate as if they were real control stations in an engine room or engine control room. All presentation shall be done by means of graphical high resolution monitors presenting equivalent engine control room man-machine interface such as console facilities as well as mimic diagrams of systems including operation facilities. The keyboard should contain dedicated keys for different functions, and the cursor should be operated by means of a trackball.

All student workstations can run the software models independently of each other during off-line operation. During on-line operation, all trainee workstations can run the same model where each student might be in charge of different systems. Each workstation may have a log printer. The student's exercises shall be possible to be recorded and replayed. Consequently, this version is suitable for in-depth studies of different processes and subsystems. However, this version still does not sufficiently replicate, due to a lack in realism of a real engine room.

### 3.2.3 "PART TASK SIMULATOR".

The definition for a Part Task Simulator is given in the STW sub-committee, agenda item 3 on the 25th session (STW/25/3/7, 1993) report as:

> An instrument or facility which is capable of simulating a single or a limited combination of tasks relating to a system.

A Part Task Simulator normally simulates part of engine room or an engine room system, such as electrical power distribution system and sea water cooling system. It enables trainees to master well each engine room system before going for a complete engine room simulation exercise. A typical series of Part Task Simulator produced by Haven Automation is as the following:

i. Modeq 100 which simulates an electrical power plant.

ii. Modeq 200 which simulates a motor and motor drive.

iii. Modeq 300 which simulates a marine diesel engine.

During the off-line operation of a Workstation Version Simulator, all student workstations are run with independent software model. Thus, each student workstation is only capable of working on only one engine room system. At that time, each student workstation is considered as a Part Task Simulator.

Similarly, a CBT Simulator is also considered as a Part Task Simulator because only one engine room system could be displayed each time. However, a Part Task Simulator is not necessarily a CBT Simulator because the Part Task Simulator may not use any computer for simulation.

### 3.2.4 "ENGINE ROOM SIMULATOR (FULL-TASK/MISSION OPERATIONAL)".

The definition for a Full-Task/Mission Simulator is given in the STW sub-committee, agenda item 3 on the 25th session (STW/25/3/7, 1993) report as:

> An instrument or facility which is capable of simulating a total engine room environment.

An 'Engine Room Simulator' simulates the whole engine room system with a dynamic real-time computerised software and various replica hardware as found onboard a real ship. The hardware and software are arranged over separate rooms that allow users to work under conditions close to a real ship environment. The minimum simulation shall have a main propulsion system and various auxiliary systems.

This 'Engine Room Simulator' should be designed in such a way that all operational actions of the users will produce fair operational functions of a typical ship engine room system. Therefore, an 'Engine Room Simulator' is a full task and operational type. There are three types of propulsion plant simulated by the 'Engine Room Simulator' existing today. Those are:

i. Steam propulsion plant 'Engine Room Simulator'.
ii. Medium speed diesel propulsion plant 'Engine Room Simulator'.
iii. Slow-speed diesel propulsion plant 'Engine Room Simulator'.

### 3.2.5 COMBINATION OF BOTH 'ENGINE ROOM SIMULATOR (FULL TASK/MISSION OPERATIONAL)' AND 'WORKSTATION VERSION SIMULATOR' - "COMBINED VERSION SIMULATOR"

The 'Engine Room Simulator' and the 'Workstation Version Simulator' can simply be connected through a ethernet 'Local Area Network', provided their software and hardware are compatible, thus, resulting in the formation of a 'Combined Version Simulator'.

This way of configuration offers much greater flexibility in training objectives, scheduling and instructor involvement. Furthermore, the number of trainees can be easily increased just by extending more workstations to a maximum limit, and allowing them to experience the realistic operational training with in-depth analysis of different processes. Probably, this 'Combined Version Simulator' is able to provide an optimum training solution for maritime institutions. Figure 3.2 shows a typical configuration of a Combined Version Simulator.

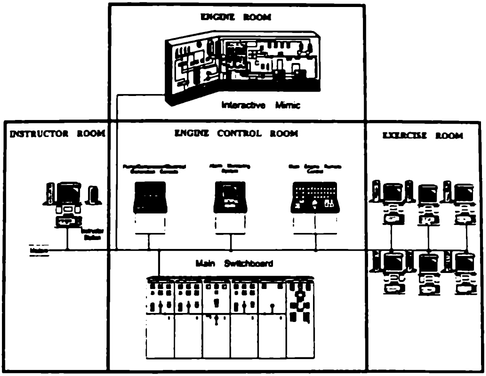


**Figure 3.2: Typical Configuration of a Combined Version Simulator.**
**Source: Propulsion Plant Training (PPT 2000) Manual, Norcontrol.**

## 3.3 ADVANTAGES AND LIMITATIONS ON THE USE OF FULL-TASK/MISSION OPERATIONAL ENGINE ROOM SIMULATOR (ERS).

While the author was doing field study at the Maritime University of Szczecin in Poland, Marine Technical College (MTC) in Japan, and Bakkenteigen

Polytechnic at Tonsberg in Norway, he took such opportunities to observe various types of different maker's full-task/mission operational ERSs at those institutions. The author learnt not only about those facilities which are able to provide tremendous benefits, but also about those which have some limitations.

Professor Toshio Hikima, a visiting professor from the Marine Technical College, was interviewed by the author (1998). According to him, the ERS in the MTC, 'the best installed full-task operational ERS in Japan', is no doubt a very important training and retraining device in Japan for engineering cadets and engineer officers respectively. The ERS is used to train engineering cadets before they serve as junior engineer officers onboard merchant ships. This is because the cadets' sea training onboard those Japanese training ships is not sufficient for them to serve on more modern merchant ships in Japan which have various types of sophisticated machinery and control systems. However, the ERS in MTC could be easily adapted to suit and enhance the training. The ERS in the MTC has a simulation of a wide range of modern engine room machinery which is claimed to be suitable for most of the existing merchant ship training in Japan. In addition, it is a trend now for Japanese engineer officers to work alternately a few years on land and at sea. This will require the retraining of engineer officers. It is found to be cost effective to retrain Japanese engineer officers with the use of ERS in MTC, rather than send them for retraining onboard merchant ships where shipping companies have to bare the high cost of salaries, and for a much longer period of training.

With all the knowledge and experience gained during field study from experienced ERS instructors, visiting professors and professors of WMU, the author has synthesised the various advantages and limitations on the use of full-task/mission operational ERS.

### 3.3.1 ADVANTAGES OF FULL-TASK/MISSION OPERATIONAL ERS.

The various advantages of engine room simulators used for training are:

i) No risk to life, environment and equipment damage.

Since the simulated environment is not real, therefore the operation of ERS has no risk to human lives, environment (such as air and sea pollution) and equipment damage. Hence, it is a good place to make mistakes without giving detrimental effects. The best example is when ERS is being used for emergency situations such as the introduction of various faults by manipulating operational parameters to create emergency situations, emergency stoppages and the running of main engine and total electric power failure (blackout). Therefore, ERS allows users to learn from mistakes without any detrimental cost as well.

ii) Gain operational experience within a much shorter period of time.

The trainees are able to gain operational experience by practising many selected tasks with ERS. The selected tasks could be the skill and knowledge from years of operational experience at sea, which can be trained within a training period of a few weeks. Moreover, the dynamic real-time ERS could be accelerated for briefing and debriefing exercises. Therefore, ERS saves time.

iii) Various categories of training can be tailored.

The categories of training can range from the level of novice to the level of experience senior engineer. This can be done easily by adjusting the degree of difficulty and complexity of the training in order to match the knowledge and skill of the appropriate level.

iv) "Repeatability" of training scenario.

The "repeatability" of training scenario enables each trainee to be trained under the exactly the same scenario. This is to allow consistency of training through better monitoring of the results and analysis of any trends. In addition, during debriefing sessions, the repeated or replayed training scenarios can be used for discussion and clarification among trainees and instructor.

v) Develop better operational procedures and monitoring techniques.

Through the extensive data collection from the ERS training, research etc, development of better operational procedures and monitoring techniques for engine room machinery will be encouraged.

vi) Promote motivation and self-confidence.

The dynamic real-time ERS has a real-time response of engine room systems besides having some replica hardware. This facility allows the trainees to see the cause-and-effect of their own performance immediately. This directly influences the enthusiasm of trainees and promotes motivation to learn. Moreover, the skill and knowledge acquired by trainees is by their own hands-on experience which will boost up their self-confidence towards the handling of the engine room.

### 3.3.2 LIMITATIONS OF FULL-TASK/MISSION OPERATIONAL ERS.

The various main limitations on the use of ERS are as follows:

i) Technical skills such as dismantling and reassembling of machinery mechanical components cannot he demonstrated on ERS.

ii) Since there is no real engine being used for simulation therefore users have no chance to feel engine heat, see smoke/vapour/fume/fire and smell burns or gas leakage; except they can only hear the simulated engine sounds and vibrations through loudspeakers. Thus, it is not good enough for non UMS ship operation training which requires those human senses to perform excellent engine room watchkeeping.

iii) There is no specific governing body or authority to control the quality and set a certain minimum criteria of ERS since it is not yet a mandatory requirement under STCW95 to use the simulator for training/assessing the competence of engine personnel. Therefore, some ERS makers may overlook certain important features during modelling stage. As a result, the ERS produced will be of inferior quality which could become a misleading training tool.

iv) The initial cost to purchase the full-task/mission operational ERS is considered quite high for MET institutions in most developing countries.

v) There is a need for specially trained instructors who have the skills and knowledge requirements to conduct training.

vi) There is a low trainee to instructor ratio. For a full task/mission operational ERS the ratio is only about 5:1. However, if the full-task/mission operational ERS is combined with the workstation version then the ratio will be very much improved.

### 3.4 ALTERNATIVE USE OF ERS.

#### 3.4.1 RESEARCH.

Ideally, the dynamic real-time process of ERS should be modelled to an extent of high physical and functional fidelity. With such a feature, the simulator is not only good for training purposes alone but it can also be used for research purposes. The following are some possible research applications that could be achieved with the use of ERS.

- To study fuel economy and propulsion plant efficiency optimisation.
- To study the causes of machinery failure. After the causes have been identified, appropriate measures taken should be introduced to the simulator. This is to confirm whether the measures taken are effective or not.
- To study the reaction of operators when they are under stress.
- Validation of the use of simulators for operator performance assessments.
- To study plant and operator interface relationships.
- To improve the safety of machinery operational procedures.
- To establish, as much as possible, the fail-safe situation in the engine room.

#### 3.4.2 ASSESSMENT OF COMPETENCE.

Assessment of competence of seafarers is normally used for the purposes of recruitment and promotion by shipping companies. However, at maritime training institutions, assessment of competence with the use of ERS is important for the purposes of trainee certification and evaluating training effectiveness.

In order to have a reliable and valid assessment of competence, the following matters should be observed:

- The ERS used should have high accuracy in all aspects of simulation and meet STCW95 guidelines.
- There should have a clear and consistent assessment strategy for each category of assessment.
- For any assessment associated with certification, the National Authority should specify the requirements for the simulator and endorse the assessment process.
- Assessors should have sufficient sea experience and suitably trained. Beside, the assessors should be evaluated both by the authority and trainees.
- In advance of the assessment, students should have sufficient time for familiarisation practice on the simulator. Assessors should carefully organise the process of assessment and keep an ideal assessment environment.
- For compliance to STCW95, the performance standards of main and auxiliary machinery operation simulation should follow closely the recommended performance standards as stipulated 'on page 200 of STCW Code B'. In addition, the assessment procedures and qualification of assessors should be as 'on page 23 of STCW Code A'.
- Although an ERS can provide a large portion of valid and reliable assessment of competence, a complete (total) competence as in the real engine room environment is not possible. Therefore, certain areas of competent assessment need to be carried out by combining with other assessment tools such as a real engine workshop or onboard training ships.

## 3.5 STCW95 AND THE USE OF SIMULATORS.

The STCW95 is an instrument adopted by International Maritime Organisation (IMO) in 1995 in order to provide a mechanism to raise the standards of competence and professionalism of seafarers upon whom the safety of life, property and the environment depends. This is to ensure that maritime casualties and pollution incidents which are caused mostly due to human error are to be reduced. As such, as stipulated in the STCW Code, the highest practicable standards of training, certification and competence should be maintained among seafarers in order to achieve and maintain the highest practicable standards for maritime safety and efficiency with the maximum protection of the marine environment.

Regulation I/12 of the STCW Convention; Section A-I/12 of the STCW Code A; and Section B-I/12 of the STCW Code B consider the use of simulators. Besides being a training tool, the simulator is used in many assessment of competence areas for certification and alternative certification of seafarers. The simulators used in this respect are divided into Mandatory Type of Simulation and Non-Mandatory Type of Simulation.

The Mandatory Types of Simulation are applied to radar simulation and automatic radar plotting aids (ARPA) simulation.

The Non-Mandatory Types of Simulation are applied to the following:

- Navigation and watchkeeping;
- Ship handling and manoeuvring;
- Cargo handling and stowage;
- Radiocommunications; and
- Main and auxiliary machinery operation.

For the Engine Department the mandatory minimum requirements for certification of junior and senior engineer officers at the operational and management levels respectively should be required to demonstrate the ability to undertake various tasks, duties and responsibilities by examination and assessment of the evidence obtained from one or more of the following:

- Approved in-service experience;
- Approved training ship experience;
- Approved simulator training, where appropriate.

Obviously, the above simulator training is just an option for the engineering officer. Therefore, the simulator training for an engineering officer is not a mandatory requirement under STCW95, but acts as an important training tool to enhance the competence of engineer officers.

Some examples of tasks, duties and responsibilities of engineering officers who have no compulsion to be assessed and trained by the use of simulators are the following:

For duty engineers at the operational level either in UMS or non-UMS ship operations.

- Maintain a safe engineering watch.
- Operate main and auxiliary machinery and associated control systems.
- Operate pumping systems and associated control systems.
- Operate alternator, generators and control systems.
- Maintain marine engineering systems including control systems.
- Maintain seaworthiness of the ship.

For chief and second engineer officers at the management level.

- Plan and schedule operations.

- Start up and shut down main propulsion and auxiliary machinery, including associated systems.
- Operate, monitor and evaluate engine performance and capacity.
- Manage fuel and ballast operations.
- Use internal communication systems.
- Operate electrical and electronic control equipment.
- Test; detect faults and maintain; and restore; electrical and electronic control equipment to operating condition.
- Detect and identify the cause of machinery malfunctions and correct the faults.
- Control trim, stability and stress of the ship.
- Monitor and control compliance with legislative requirements and measures to ensure safety of life at sea and protection of the marine environment.

STCW95 does not provide any recommendation to use the simulator for certification of deck and engine ratings who are at the support level. In fact, it is quite important to expose the personnel at the support level to learn by using a simulator too. They will thus be motivated and eventually gain interest and confidence in their career undertaking. Regarding the issue of alternative certificates, it is noted that the requirements to use the simulator for assessment and training are the same as for certification.

STCW95 has been structured to allow simulator performance standards to be transferred from the non-mandatory STCW Code B to the mandatory STCW Code A. Besides, the amendments to STCW Code B can be made by the Maritime Safety Committee (MSC) of IMO through its own rules. Consequently, the process of updating STCW95 can be achieved within a much shorter period of time. Therefore, it is important to follow closely the guidelines provided in Section B-I/12 of STCW Code B for implementation of simulator training and assessment.

## 3.6 INTERNATIONAL MARINE SIMULATOR ORGANISATION.

### 3.6.1 INTERNATIONAL MARINE SIMULATOR FORUM (IMSF).

The influx of sophisticated modern technology into the shipping industry has resulted in the necessity to use simulators for training, assessment and research. In September, 1978, the world's first International Conference on Marine Simulation (MARSIM78) was held under the sponsorship of a few maritime institutes. During the same year, the International Maritime Organisation (IMO) established the International Marine Simulator Forum (IMSF) in order to provide a forum to discuss the operational experiences and problems of the simulator operator community. The members of IMSF consists of operators of ship manoeuvring simulators. Towards the end of the MARSIM78 conference, IMSF held a meeting and decided to initiate the future international conferences in Marine Simulation i.e. MARSIM81, 84, 87, 90, 93, 96.

The various reasons for IMSF to initiate the international conferences are as follows:

- To allow the effective exchange of information, experiences, and views about simulator developments internationally among all end users of simulators including actively serving seafarers, instructors, researchers and their organisations. As such, it would provide valuable feedback to the maritime simulator community, for the improvement of their training, assessment and research programs, and the progression of knowledge.
- To improve design, construction and performance standards of simulators hardware/software.
- To encourage uniformity of marine simulator standards world-wide.

- To find a cost-effective method of using simulators for training, assessment and research. This aspect exposes a challenge to the simulator manufacturing community to provide cost-effective, full-mission/task/operational simulators that can be utilised by developing countries within their financial constraints.
- To promote the use of simulators in order to improve maritime safety and productivity at sea.

### 3.6.2 INTERNATIONAL CONFERENCE ON ENGINE ROOM SIMULATORS (ICERS), ORGANISED BY THE INTERNATIONAL MARITIME LECTURERS ASSOCIATION (IMLA).

The world's first International Conference on Engine Room Simulators (ICERS1) was held between 7th-11th June, 1993, in Nantes, France. The following alternate years 1995 and 1997, the ICERS2 and ICERS3 respectively were successfully convened. These International Conferences on Engine Room Simulators were convened by IMLA in co-operation with World Maritime University (WMU) and other maritime institutions.

IMLA was founded in 1980. Since then, IMLA has convened many other international conferences such as International Navigation Simulator Lecturers' Conference (INSLC) since 1980. In the future IMLA is going to convene more forms of marine simulator and educational conferences in order to expose mainly educationalists to the latest developments. Such a massive effort and the contributions of IMLA to the maritime world finally resulted in IMLA being granted consultative status by the IMO at the end of 1994.

With the periodic ICERS conferences, the users of ERS throughout the world can now can have the chance to exchange information, experiences and views about

ERS developments. This will harmonise and improve ERS standards for training, assessment and research world-wide. Besides, the fruitful conclusions and recommendations of the ICERS conferences could be very important information to be transmitted to IMO via IMLA for the future amendments of the STCW Convention and STCW Code regarding the main and auxiliary machinery operational simulation.

# CHAPTER 4

# PUO AND ITS MARINE ENGINEERING DIPLOMA COURSE (MEDC).

## 4.1 BACKGROUND OF THE MEDC IN PUO.

Politeknik Ungku Omar (PUO), situated in Ipoh, Perak, West Malaysia, was established in 1969. In 1972, under the Colombo Plan, the Marine Engineering Diploma Course for engineering cadets was set up in PUO, in order to cope with the demand for trained engineering personnel to man Malaysian ships. The Colombo Plan was a commonwealth funding scheme for education in the less developed commonwealth countries.

PUO is a higher education technical institute reporting to the Technical and Vocational Division of the Ministry of Education in Malaysia. Under the Colombo Plan, the Japanese Government provided advisers and equipment to implement the scheme. The Malaysian Government provided the premises, workshops, local teaching staff, additional equipment and operating budget.

Since 1984, the Japanese government has stopped sending advisers (experts). However, continuous assistance in the way of supplying machinery spare parts and technical know-how has remained available from the Japan International Co-operation Agency (JICA) until today. This is considered as one of the successful JICA's project. Therefore, further development of this Marine Engineering Diploma

Course now mainly depends on PUO effort. In order to ensure continuous improvement, PUO has a close relationships and works closely with shipping companies and the Marine Department of the Ministry of Transport to acquire the latest information.

Presently, there is a need to upgrade PUO's existing marine workshop training, preferably with additional Engine Room Simulator (ERS) training, in order to cope with the high technology ships of today and the future.

As mentioned in Chapter 2, currently marine engine systems are generally intended for integrated and centralised operation in the control room, as seen in automated ships. Hence, the use of the engine room simulator for operational and emergency training is one of the most effective methods of training on such engine systems. In addition, this is the most appropriate method of training for engineering cadets without risking lives or equipment, especially when they are inexperienced and have a high tendency to make mistakes. The engine room simulator is capable of simulating actual engine systems for the purpose of training personnel or analysing the research such as how to study human behaviour when in a stressed, emergency situation. However, in many other research areas such as improving the engine design of a system, the ERS being used today in MET is not good enough, due to lack of fidelity. Regarding the associated problems arising from on-board job training today, ERS should be able to overcome most of these problems.

## 4.2. MARINE ENGINEERING DEPARTMENT IN THE PUO.

The PUO consists of five departments. They are namely;

- Mechanical Engineering Department,
- Electrical Engineering Department,

- Civil Engineering Department,
- Commerce Department, and
- Marine Engineering Department.

The present number of students in the above Departments are 708, 960, 822, 621 and 273 respectively.

In addition, there is a Language/Religious/Moral Unit taking care of all the PUO students English Language (Technical), Islamic and Moral studies.

The Marine Engineering Department in PUO runs one regular main course, namely the Marine Engineering Diploma Course, and some other irregular modular courses for PUO cadets, engine ratings and shipyard technicians. The output from the Marine Engineering Diploma Course averages about ninety graduates per year.

### 4.2.1 INFRASTRUCTURE AND EQUIPMENT.

The Marine Engineering Department is well equipped with a working shipboard engine room and deck machinery distributed over several workshops; and class rooms with lecturing facilities. The engine room and deck machinery were provided at the time when the MEDC was being established. As such, the automation system for the engine room and deck machinery is a semiautomatic system, which was popular in those days. They are all located within the department. These include;

i. A main reversible slow speed marine diesel engine propulsion plant with water brake dynamometer.

ii. Two complete sets of medium-high speed diesel engine driven electric generators with a synchronising panel, switchboard and loading tank.

iii. A low pressure marine water tube boiler producing saturated steam.

iv. An impulse type steam turbine with water brake dynamometer.

v. An oil purifier.

vi. A steering gear system.

vii. An oily water separator.

viii. A plate type fresh water generator.

ix. A main air compressor.

x. A refrigerating plant for provisions with vegetable and meat/fish chambers.

xi. Shipboard electric motors and pumps.

xii. A hydraulic mooring winch.

xiii. An electric windlass.

xiv. A machining and welding workshop.

xv. A computer laboratory (LAN system).

In addition, being located in a polytechnic, a wide variety of laboratories at other departments are available for use by marine engineering students; these include the electrical, electronic, thermodynamic and materials laboratories.

### 4.2.2 ACADEMIC AND SUPPORT STAFF.

There are sixteen academic staff including the Head of Department. The qualification of the staff are as follows:

- MSc Master Degree in Mechanical Engineering (1 person).
- MSc Master Degree in Marine Engineering (2 persons).
- BSc Bachelor Degree in Naval Architecture (1 person).
- BSc Bachelor Degree in Mechanical Engineering (2 persons).
- BSc Bachelor Degree in Electrical Engineering (1 person).
- Second Class C.O.C. with Diploma in Marine Engineering (4 persons).

- Fourth Class C.O.C. with Diploma in Marine Engineering (2 persons).
- Diploma in Marine Engineering (1 person).
- Diploma in Technical Education and Training (1 person).
- Diploma in Electrical Engineering (1 person).

The supporting staff are one technician, one engine driver and two general assistants.

In order to have a brief idea of the overall academic staffs' qualifications and experiences, let us divide them into four criteria. Namely;

- Certificate of competency (COC).
- Academic qualification (AQ).
- Sea experience, actual sea time (SE).
- Teaching experience (TE).

The details of the four criteria are stipulated in the following Table 4.1.

**Table 4.1: Academic staff qualifications and experience.**

| Value | COC Levels | SE (sea time) | AQ Levels | TE |
|---|---|---|---|---|
| 5 | 1st class COC | 5 years | PhD | 5 years |
| 4 | 2nd class COC | 4 years | MSc | 4 years |
| 3 | 4th class COC | 3 years | BSc | 3 years |
| 2 | 1st class Engine Driver | 2 years | Diploma | 2 years |
| 1 | 2nd/3rd class Engine Driver | 1 year | Certificate | 1 year |
| 0 | - | 0 | - | 0 |

**Source: Marine Engineering Department, Politeknik Ungku Omar.**

With reference to Table 4.1, the average values of the academic staff qualifications and experience calculated are as follows;

- COC approximately equal to 1.4.
- SE approximately equal to 1.9.
- AQ approximately equal to 2.6.
- TE equal to 5.0.

Those four average calculated values could be clearly represented as in the following Figure 4.1.

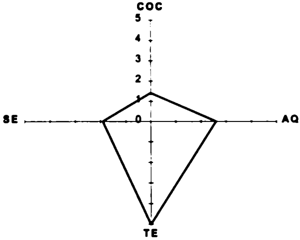


**Figure 4.1: Qualifications and Experience of Academic Staff at MED in PUO.**

With reference to Figure 4.1, in an ideal MET environment, all those four criteria should be well balanced at the maximum values of five(5). This would enable the best possible blending of the academic staff qualifications and experience. However, the present situation still needs the continuous improvement of staff, especially in the area of COC and sea experience. Normally, it is more difficult to acquire a COC and sea experience through the existing academic staff due to the unavailability of sea training and their unwillingness to go for sea training. As such, if any new academic staff is to be taken on in the future, they should preferably have the highest possible COC qualification and a reasonably wide sea experience.

## 4.3. STRUCTURE AND GRADUATES' SEA CAREERS.

The Marine Engineering Diploma Course is a sandwiched four-year course, which is divided into five phases as detailed below:

Phase 1: Semester One and Semester Two, for a duration of six months each semester. Students study at PUO as pre-sea cadets.

Phase 2: Semester Three, for a duration of six months. Students undergo five months shipyard training (with PUO correspondent course).

Phase 3: Semester Four, for a duration of six months. Students study at PUO as pre-sea cadets.

Phase 4: Semester Five and Semester Six, for a duration of twelve months. Students undergo sea training onboard merchant ships as assistant engineer officers (with PUO correspondent course).

Phase 5: Semester Seven and Semester Eight, for a duration of six months each semester. Students study at PUO as post-sea cadets.

Since Malaysia is a party to the International Convention on STCW, therefore, the MEDC structure is basically designed to comply at least with the STCW78 requirements. However, by the end of February, 2002, the MEDC should comply with the STCW95. Regarding training and certification, STCW95 requires PUO to have a monitoring of standards by a quality assurance system such as ISO 9002 to be in place. Therefore, additional ERS training programme to the MEDC structure will no doubt enhance and raise the standard of the education and training, as promoted by STCW95.

### 4.3.1 CAREER AT SEA

Upon completion of the Marine Engineering Diploma Course, the students can make an attempt to pass the Fourth Class C.O.C. oral examination. The graduates can then proceed to sea service as Junior Engineer Officers.

After acquiring a minimum of eighteen months approved sea service experience as Engineer Officer onboard merchant ships, (of which a minimum of twelve months must be on ships with not less than 3000 kilowatts of main engine power) the engineer officer should attend a three month Second Class C.O.C. Preparatory Course and some other short period of upgrading courses before attempting the Second Class C.O.C. written and oral examinations. Upon passing the examinations, the Engineer Officer is eligible to be promoted as Second Engineer Officer.

An Engineer Officer holding a Second Class C.O.C. needs another eighteen months of approved sea service experience and then should attend a three month First Class C.O.C. Preparatory Course before attempting the First Class C.O.C. written and oral examinations. Upon passing the examinations, the Engineer Officer is eligible to be promoted as Chief Engineer Officer.

For information, the First and Second C.O.C. Preparatory Courses and other upgrading courses are available in Akademi Laut Malaysia (ALAM), which is a branch campus of the World Maritime University. Currently, all the C.O.C. examinations are conducted by the Marine Department that is under the Ministry of Transport. This responsibility might be delegated to maritime education and training institutions in the future.

## 4.4 PRESENT CURRICULUM OF THE MEDC.

The following Table 4.2 is the curriculum of the MEDC when the students are studying at PUO undergoing Phase 1, Phase 3 and Phase 5. Under Phase 2 and Phase 4, the students are undergoing shipyard training and sea training respectively.

**Table 4.2: The MEDC Curriculum.**

| Subjects | Semester (S) | | | | | T/C |
|---|---|---|---|---|---|---|
| | S1 | S2 | S4 | S7 | S8 | |
| Mathematics | 4 | 4 | | 4 | | 12 |
| Engineering Science | 6 | | | | | 6 |
| Engineering Drawing | 4 | 4 | | 3 | | 11 |
| Workshop Technology | 8 | 8 | | | | 16 |
| Heat & Fluid Technology | 3 | 3 | | | | 3 |
| Marine Engineering Practice | 4 | | 3 | | | 7 |
| Electrical Technology | | 7 | 4 | 4 | | 15 |
| Mechanics of Machines | | 4 | | | | 4 |
| Control Engineering | | 4 | | | 5 | 9 |
| Naval Architecture | | 2 | 4 | 3 | 3 | 12 |
| Strength of Materials | | | 6 | | | 6 |
| Internal Combustion Engines | | | 4 | | 4 | 8 |
| Steam Engineering | | | 4 | 4 | 3 | 11 |
| Marine Auxiliary Machinery | | | 4 | | 4 | 8 |
| Mechanical Technology | | | | 4 | | 4 |
| Engineering Design | | | | 2 | | 2 |
| Materials Technology | | | | 4 | | 4 |
| Applied Electronics | | | | | 4 | 4 |
| Marine Engineering & Legislation | | | | | 4 | 4 |
| Marine Workshop Practice | | | 8 | 8 | 8 | 24 |
| Moral/Islamic Education | 2 | 1 | 2 | | 3 | 8 |
| English Language (Technical) | | 3 | 3 | 2 | | 8 |
| Computer Practice | 2 | | | | | 2 |
| Total classes per week | 36 | 40 | 41 | 36 | 38 | (191) |
| No. of study week per Semester | 19 | 19 | 19 | 19 | 19 | |
| Total classes per Semester | 684 | 760 | 779 | 684 | 722 | (3629) |
| Key: T/C - Total classes per week. | Note: Duration of each class is 45 minutes. | | | | | |

**Source: Marine Engineering Department, Politeknik Ungku Omar.**

## 4.5. IDENTIFICATION OF THE EXISTING WEAKNESSES.

Obviously, from Chapter 2, the cadet sea training is seriously affected by the training on high technology merchant ships. Therefore, a supplement of competency based training is indeed needed for the students. PUO is very concerned about this matter and intends to supplement whatever is lacking at the institution.

Since the beginning of the Marine Engineering Diploma Course at PUO, the theoretical academic curriculum has continuously been updated and improved. Unfortunately, the curriculum of the Marine Workshop Practice (that is intended for competency (skill) based type of learning and training) has only had limited changes of improvement. This is mainly due to no upgrading of the existing marine workshop facilities or unavailability of suitable training equipment like an ERS. Consequently, the curriculum of the Marine Workshop Practice is unable to develop at the same pace as required by the latest training needs.

Evidently, sampling from the cadet's sea training record books and correspondent courses, some of the cadets are unable to fulfil the specified tasks as required during the twelve months sea training phase.

According to the Training Record book for the Seagoing Phase of the IMO Model Course 7.04 (1991, 6):

> Parts or the whole of some assignments may not be completed by the end of the seagoing phase. A record of all such deficiencies should be entered on the page provided. This then gives the college or Administration the opportunity to take appropriate action in phase 3.

The above implies that PUO has to find a solution for those deficiencies. This problem should be discussed with the shipping companies who have provided the sea training to the cadets. The shipping companies are normally the sponsors of the cadets, which the cadets have to serve for in the future. Moreover, under regulation I/14 of STCW95 Convention, the shipping companies are held responsible for the assignment of seafarers for service on their ships. Therefore, shipping companies are the crucial partners for PUO in order to overcome this problem.

### 4.5.1 MARINE WORKSHOP FACILITIES.

The present marine workshop facilities are distributed over several workshops, including the Main Engine Workshop, Steam Boiler Workshop, Steam Turbine Workshop, Electric Generator Workshop, Oil Purifier Workshop, Steering Gear Workshop.

Today, marine engine systems are generally intended for integrated operation and centralised operation in the control room, as seen in the automated ship. Unfortunately, there is no integration of automation between each marine workshop in PUO. The workshops all have independent monitoring and control systems. This situation is not good enough for the training of UMS ship operation. Therefore, it is suggested to have at least an integrated monitoring system for monitoring of all the workshop machinery operating parameters in a common control room.

### 4.5.2 SEA TRAINING PROGRAMME.

The twelve month cadet sea training programme could not properly fulfil the present training needs as mentioned in Chapter 2. Of course, ship operators will not risk or sacrifice the safety of the ship for training purposes. In addition, under STCW95, Section A-I/6 item number 2:

> Persons conducting in-service training or assessment on board ship shall only do so when such training or assessment will not adversely affect the normal operation of the ship and they can dedicate their time and attention to training or assessment.

The above implies that UMS ship operation with reduced manpower and a tight schedule as mentioned in Chapter 2, will not allow sufficient competency based training to be conducted on board UMS ships anymore. Therefore, it is wise to train whatever that is lacking at PUO. PUO should be able to cope with this properly provided there is a reasonable upgrading of the present marine workshop facilities with additional modern training equipment like a full-task/mission operational ERS for operational training.

According to the Regulation III/I of STCW95 Convention, the mandatory minimum requirement for certification of officer in charge of an engineering watch needs a minimum of six months approved seagoing service. Therefore, the Marine Engineering Diploma Course at PUO has much exceeded that requirement.

Since the present twelve months sea training phase for the PUO cadets can not yield optimum benefit, it is therefore suggested that the sea training period be reduced. However, a minimum period of six months or more for engineering cadet sea training should remain, which still complies with the STCW95 requirement. The reduced sea training period can then be planned by PUO for other alternative education and training like the ERS training programme which is more efficient, productive and cost effective.

# CHAPTER 5

# ENGINE ROOM SIMULATOR PROGRAMMES FOR THE MARINE ENGINEERING DIPLOMA COURSE (MEDC) AT PUO.

## 5.1 PROPOSALS FOR ERS PROGRAMMES.

ERS programmes should be designed carefully in order to suit the capability of students from different semesters. The MEDC at PUO consists of eight semesters. It is proposed to have three sessions of ERS programme within the eight semesters, in order to fully utilised the ERS facilities for the benefit of MEDC cadets.

The first session will be scheduled at the beginning of Semester 5, that is before the cadets go for sea training. As such, it is named the Pre-sea Engineering Cadet ERS Programme. The second session will be scheduled at the end of Semester 6, that is immediately after the cadets have completed their sea training. As such, it is named the Post-sea Engineering Cadet ERS Programme. The third session will be implemented immediately after the second session for the purpose of assessing the post-sea cadet's competence on par as stipulated in Table A-III/1 of STCW95. As such, it is named as Engineer Officer ERS Programme.

## 5.2 PRE-SEA ENGINEERING CADET ERS PROGRAMME (ERS1).

The main aim of this ERS programme is to motivate the pre-sea cadets to learn before they proceed for their next sea training phase. As such, the programme should not be tedious but simple, easily understood and less emphasis in complicated theory. In addition, the instructor preferably to be tactful. Hence, the main aim can be achieved easily. An assessment will be conducted. The assessment result for this programme should be credited into the Semester 5 of the MEDC curriculum as a new subject, namely ERS1. The following table 5.1 illustrates the proposed programme outline.

**Table 5.1: The Proposed Pre-sea Engineering Cadet ERS Programme (ERS1).**

| PRE-SEA ENGINEERING CADET ERS PROGRAMME (PROGRAMME OUTLINE) | | | | | | |
|---|---|---|---|---|---|---|
| LEARNING OBJECTIVES | A | B | C | D | E | Q |
| Familiarisation with:<br>• ERS configuration.<br>• Various main/auxiliary systems and pipeline tracing.<br>• Alarm and communication systems.<br>• Safety interlocks and controls.<br>• Various fail-safe operations.<br>• Trips and resetting.<br>• Procedures to operate main/auxiliary systems. | 1 | 2 | 3 | 1 | 7 | M |
| Plant operation from wheel-house/engine control room/local positions (where ever appropriate) during port stay:<br>• Transferring of bunker fuel, lubricating oils, fresh water and ballast.<br>• Warming up and raising steam in boiler.<br>• Starting up electric generators and parallel operations.<br>• Start-up and shut-down various auxiliary machinery. | 1 | 2 | 3 | 1 | 7 | T |
| Plant operation from wheel-house/engine control room/local positions (where ever appropriate):<br>When ship is going to leave port,<br>• Preparation of main propulsion engine such as warming up, start-up necessary auxiliary machinery and test-gear.<br>When ship is leaving port,<br>• Manoeuvring of propulsion plant until full-away.<br>After full-away,<br>• Change over from light fuel and high sea-chest to heavy fuel and low sea-chest respectively. | 1 | 2 | 3 | 1 | 7 | W |

| PRE-SEA ENGINEERING CADET ERS PROGRAMME (PROGRAMME OUTLINE) | | | | | | |
|---|---|---|---|---|---|---|
| LEARNING OBJECTIVES | A | B | C | D | E | Q |
| • Start-up shaft electric generator and shut-down diesel electric generators.<br>• Change over from oil fired boiler to exhaust boiler, then start-up turbo electric generator, fresh water generators and purifiers. | | | | | | |
| Sea watchkeeping at wheel-house (UMS Ship operation), engine control room, and local control stations (emergency operation).<br>• Operation of; bilge systems with the use of oily water separator, ballast and incinerator; with regard to MARPOL (method of filling up oil record book).<br>• Filling up of log books and analysing the data.<br>• Simple fault diagnosis, such as from temperatures and pressures.<br>• Some performance monitoring, such as power and draw card diagrams.<br>• Procedures of handing over and accepting an engineering watch. | 1 | 2 | 3 | 1 | 7 | T |
| Plant operation from wheel-house/engine control room/local control stations (where ever appropriate) when the ship is arriving port until finished with engine:<br>• Similar to when the ship is leaving port but just in an opposite manner. For example, change over from shaft generator to diesel generator before telegraph is on stand-by.<br>Plant operation during emergency situation:<br>• To resume normal operation of the plant after a black-out has occurred.<br>• To handle situations like under piston scavenge fire and steering gear failure.<br>• To execute emergency run of main propulsion from full-ahead to full-astern and vice versa. | 1 | 2 | 3 | 1 | 7 | F |
| TOTAL: | 5 | 10 | 15 | 5 | 35 | 5 |
| Keys of A, B, C, D, E, and Q: | | | | | | |
| A: Instructor briefing time in hour. (0800hrs. - 0900hrs.) | | | | | | |
| B: Instructor demonstration time in hour. (0945hrs. - 1145hrs.) | | | | | | |
| C: Trainee exercise time in hour. (1245hrs. - 1545hrs.) | | | | | | |
| D: Instructor debriefing time in hour. (1600hrs. - 1700hrs.) | | | | | | |
| E: Total ERS learning time in hour for each day. | | | | | | |
| Q: Week days, M-Monday, T-Tuesday, W-Wednesday, T -Thursday, and F-Friday. | | | | | | |

## 5.3 POST-SEA ENGINEERING CADET ERS PROGRAMME (ERS2).

The main aim of this programme is to rectify any deficiency found in the cadet sea training record book besides enhancing the training of post-sea cadets. This programme also prepares the post-sea cadets for the next Engineer officer ERS Programme which complies with STCW95. This programme has an outline similar to the Pre-sea Engineering cadet ERS Programme, except with an added appropriate deficiency area of individual cadet and the trainee exercises become slightly more advance. The similarity of the ERS programme outline will lead the cadets to master their deficient competence areas easily, besides giving them an insight into previous ERS experience. An assessment will be conducted. The result will be credited into the Semester 6 of MEDC curriculum as a new subject namely ERS2. The following table 5.2 illustrates the proposed programme outline.

**Table 5.2: The Proposed Post-sea Engineering Cadet ERS Programme (ERS2).**

| POST-SEA ENGINEERING CADET ERS PROGRAMME (PROGRAMME OUTLINE) | | | | | | |
|---|---|---|---|---|---|---|
| LEARNING OBJECTIVES | A | B | C | D | E | Q |
| Familiarisation with:<br>• ERS configuration.<br>• Various main/auxiliary systems and pipeline tracing.<br>• Alarm and communication systems.<br>• Safety interlocks and controls.<br>• Various fail-safe operations.<br>• Trips and resetting.<br>• Procedures to operate main/auxiliary systems.<br>• Appropriate training for deficiency area, to be given to the individual cadet if any. | 1 | 1 | 4 | 1 | 7 | M |
| Plant operation from wheel-house/engine control room/local positions (where ever appropriate) during port stay:<br>• Transferring of bunker fuel, lubricating oils, fresh water and ballast. | 1 | 1 | 4 | 1 | 7 | T |

| POST-SEA ENGINEERING CADET ERS PROGRAMME (PROGRAMME OUTLINE) | | | | | | |
|---|---|---|---|---|---|---|
| LEARNING OBJECTIVES | A | B | C | D | E | Q |
| • Warming up and raising steam in boiler.<br>• Starting up electric generators and parallel operations.<br>• Start-up and shut-down various auxiliary machinery.<br>• Appropriate training for deficiency area, to be given to the individual cadet if any. | | | | | | |
| Plant operation from wheel-house/engine control room/local positions (where ever appropriate):<br>When ship is going to leave port,<br>• Preparation of main propulsion engine such as warming up, start-up necessary auxiliary machinery and test-gear.<br>When ship is leaving port,<br>• Manoeuvring of propulsion plant until full-away.<br>After full-away,<br>• Change over from light fuel and high sea-chest to heavy fuel and low sea-chest respectively.<br>• Start-up shaft electric generator and shut-down diesel electric generators.<br>• Change over from oil fired boiler to exhaust boiler, then start-up turbo electric generator, fresh water generators and purifiers.<br>• Appropriate training for deficiency area, to be given to the individual cadet if any. | 1 | 1 | 4 | 1 | 7 | W |
| Sea watchkeeping at wheel-house (UMS Ship operation), engine control room, and local control stations (emergency operation).<br>• Operation of; bilge systems with the use of oily water separator, ballast and incinerator; with regard to MARPOL (method of filling up oil record book).<br>• Filling up of log books and analysing the data.<br>• Simple fault diagnosis, such as from temperatures and pressures.<br>• Some performance monitoring, such as power and draw card diagrams.<br>• Procedures of handing over and accepting an engineering watch.<br>• Appropriate training for deficiency area, to be given to the individual cadet if any. | 1 | 1 | 4 | 1 | 7 | T |
| Plant operation from wheel-house/engine control room/local control stations (where ever appropriate) when the ship is arriving port until finished with engine:<br>• Similar to when the ship is leaving port but just in an opposite manner. For example, change over from shaft generator to | | | | | | |

| POST-SEA ENGINEERING CADET ERS PROGRAMME (PROGRAMME OUTLINE) | | | | | | |
|---|---|---|---|---|---|---|
| LEARNING OBJECTIVES | A | B | C | D | E | Q |
| diesel generator before telegraph is on stand-by.<br>Plant operation during emergency situation:<br>• To resume normal operation of the plant after a black-out has occurred.<br>• To handle situations like under piston scavenge fire and steering gear failure.<br>• To execute emergency run of main propulsion from full-ahead to full-astern and vice versa.<br>• Appropriate training for deficiency area, to be given to the individual cadet if any. | 1 | 1 | 4 | 1 | 7 | F |
| TOTAL: | 5 | 5 | 20 | 5 | 35 | 5 |
| Keys of A, B, C, D, E, and Q: | | | | | | |
| A: Instructor briefing time in hour. (0800hrs. - 0900hrs.) | | | | | | |
| B: Instructor demonstration time in hour. (0945hrs. - 1045hrs.) | | | | | | |
| C: Trainee exercise/deficiency area, time in hour. (1145hrs. - 1545hrs.) | | | | | | |
| D: Instructor debriefing time in hour. (1600hrs. - 1700hrs.) | | | | | | |
| E: Total ERS learning time in hour for each day. | | | | | | |
| Q: Week days, M-Monday, T-Tuesday, W-Wednesday, T -Thursday, and F-Friday. | | | | | | |

## 5.4 ENGINEER OFFICER ERS PROGRAMME (ERS3).

The main aim of this programme is to ensure that the post-sea cadets have achieved the standard of competence with the use of ERS as stipulated in Table A-III/1 of STCW95. Therefore, any deficiency of the competence could be easily detected. An external assessor shall be invited to assess the trainees. The assessment result will not be credited into the MEDC curriculum. However, upon passing this assessment the students are eligible to make an attempt for the fourth class COC oral examination, which is after the MEDC. Therefore, it becomes a prerequisite for attempting the fourth class COC oral examination. The following table 5.3 illustrates the proposed programme outline.

**Table 5.3: The Proposed Engineer Officer ERS Programme (ERS3).**

| ENGINEER OFFICER ERS PROGRAMME (PROGRAMME OUTLINE) | | | | | | |
|---|---|---|---|---|---|---|
| LEARNING OBJECTIVES | A | B | C | D | E | Q |
| Maintain a safe engineering watch: <br>• ERS started by trainees. <br>• Group exercises. <br>• Assessor will observe the watchkeeping routine of individual trainee. <br>• Every trainee will be assessed individually for a period of 15 minutes (other trainees just as observers). | 1 | 2 | 3 | 1 | 7 | M |
| Operate main and auxiliary machinery and associated control systems: <br>• ERS started by trainees. <br>• Group exercises. <br>• Individual trainee will have to perform some operations as requested by assessor. <br>• Every trainee will be assessed individually for a period of 15 minutes (other trainees just as observers). | 1 | 2 | 3 | 1 | 7 | T |
| Operate pumping systems and associated control systems: <br>• ERS started by trainees. <br>• Group exercises. <br>• Individual trainee will have to perform some operations as requested by assessor. <br>• Every trainee will be assessed individually for a period of 15 minutes (other trainees just as observers). | 1 | 2 | 3 | 1 | 7 | W |
| Operate alternators, generators and control systems: <br>• ERS started by trainees. <br>• Group exercises. <br>• Individual trainee will have to perform some operations as requested by assessor. <br>• Every trainee will be assessed individually for a period of 15 minutes (other trainees just as observers). | 1 | 2 | 3 | 1 | 7 | T |
| Safety and emergency procedures for isolation of electrical and other types of plant and equipment required before personnel are permitted to work on such plant or equipment: <br>• ERS started by trainees. <br>• Group exercises. <br>• Individual trainee will have to perform some safety and emergency procedures, as requested by assessor to handle an | 1 | 2 | 3 | 1 | 7 | F |

| ENGINEER OFFICER ERS PROGRAMME (PROGRAMME OUTLINE) | | | | | | |
|---|---|---|---|---|---|---|
| LEARNING OBJECTIVES | A | B | C | D | E | Q |
| emergency situation of which is introduced by the assessor.<br>• Every trainee will be assessed individually for a period of 15 minutes (other trainees just as observers). | | | | | | |
| TOTAL: | 5 | 10 | 15 | 5 | 35 | 5 |
| Keys of A, B, C, D, E, and Q. | | | | | | |
| A: Instructor briefing, time in hour. (0800hrs. - 0900hrs.) | | | | | | |
| B: Trainee exercise, time in hour. (0945hrs. - 1145hrs.) | | | | | | |
| C: Trainee assessment, time in hour. (1245hrs. - 1545hrs.) | | | | | | |
| D: Instructor debriefing, time in hour. (1600hrs. - 1700hrs.) | | | | | | |
| E: Total ERS learning/assessment, time in hour for each day. | | | | | | |
| Q: Week days, M-Monday, T-Tuesday, W-Wednesday, T -Thursday, and F-Friday. | | | | | | |

## 5.5 PROPOSED SCHEDULE FOR SEMESTERS 5 & 6 OF THE MARINE ENGINEERING DIPLOMA COURSE (MEDC).

Since the average output of MEDC is about ninety graduates per year, therefore each semester will have about forty five students. For the ease of ERS training programmes, the students could be divided into six groups, consisting of about eight students per group. As such, there will be six groups of students each semester for each ERS training programme.

With reference to the Tables 5.1, 5.2 and 5.3, all of the ERS programmes needs five working days/one week to complete. Since there are six groups of students for each ERS programme, therefore, the Pre-sea, Post-sea and Engineer officer ERS Programmes, will each need six weeks/1.5 months to implement. The following Table 5.4 shows the proposed schedule for Semesters 5 & 6 of MEDC.

**Table 5.4: The Proposed Schedule for Semesters 5 & 6 of MEDC.**

| SCHEDULE FOR SEMESTERS 5 & 6 OF MARINE ENGINEERING DIPLOMA COURSE (MEDC) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Programmes | Semester 5 (months) | | | | Semester 6 (months) | | | |
| | 1.5 | 0.5 | 2.0 | 2.0 | 2.0 | 1.0 | 1.5 | 1.5 |
| ERS1 | ➔ | | | | | | | |
| Pre-seagoing buffer period | | ➔ | | | | | | |
| Approved seagoing service (engine) | | | ➔ | ➔ | ➔ | | | |
| Post-seagoing buffer period | | | | | | ➔ | | |
| ERS2 | | | | | | | ➔ | |
| Engineer officer ERS Programme, ERS3 | | | | | | | | ➔ |
| **Key: ➔ effective period.** | | | | | | | | |

Obviously, from Table 5.4, there are two periods of time in a year for which the ERS is not being used. That is from mid January until the end of March, and from mid July until the end of September. Therefore, the total unused time amounts to three months per year, which should not be wasted.

## 5.6 THE ERS PROGRAMMES AND PROSPECTS FOR THE MEDC.

With reference to Table 5.4, during each ERS training programme, every student only participates for one week out of the six weeks (or 1.5 months as indicated in table 5.4). Therefore, there will be five weeks of unplanned periods for the students. Moreover, there are three ERS training programmes within Semesters 5 & 6. Hence, the unplanned periods become a total of fifteen weeks.

Obviously, during that period of fifteen weeks, it is not possible to gather a full quorum of students. Of course, alternative training and education could be introduced. However, for a simple suggestion, it is proposed to give a task that could be done independently by individual or small groups of students. The task could be either group/individual projects, revision of studies or even writing a dissertation. In order to ensure the effective learning of students, the task's progress should be constantly monitored by the institution. Consequently, the students could have a continuous flow of education and training for the whole period of their studies, and the reduction of the six months sea training period will be effectively utilised for the benefit of students. This will provide a good ground for the Marine Engineering Diploma Course to be upgraded to a Bachelor's Degree in the future. Consequently, the Marine Engineering Course will be as competitive and attractive as other engineering courses.

## 5.7 METHODOLOGY OF ASSESSMENT.

STCW95 Section A-I/12 consists of the assessment procedures for the use of simulators. Therefore, it provides the guidelines while considering the following assessment methods. There were many assessment methods appeared in the previous ICERS. Most of the methods are of a more subjective type which depends on the assessor to give the final grading of the student. However, there is also a method mentioned using a formula which is of a more objective type as proposed by Professor Takashi Nakamura during the ICERS 2. The formula has been improved for the ICERS 3 last year. This method is presently used at the Marine Technical College in Japan. Such an assessment method could reduce the subjective judgements to a minimum. Thus, it is one of the criterion required under the STCW95 Section A-I/12, Assessment procedures, item 8.2 on page number 23.

Generally, all ERS facilities nowadays have the ability to detect any error committed by operators in the form of digital and analogue signals which could be recorded and printed by alarm and event printers respectively. In addition, for the purpose of assessment, the errors committed by the operators are preferably to be classified under three categories as proposed by Professors Kluj, S (1997). They are namely critical, moderate and minor errors. With those ideas in mind, the author has modified the formula provided by Professor Takashi Nakamura during the ICERS 3. The following is a modified formula which could give a quantified value of assessment.

$$T_A = \frac{\{\sum WE\} - (W_1E_1 + W_2E_2 + W_3E_3) - (W_4E_4 + W_5E_5 + W_6E_6)}{\{\sum WE\}} \rightarrow (continue)$$

$$(continue) \rightarrow \frac{-(W_7E_7 + W_8E_8 + W_9E_9) + W_BE_B}{} \times 100\%$$

Where,

$T_A$ $\Rightarrow$ degree of achievement in percentage.

$(W_1;W_2;W_3;W_4;W_5;W_6;W_7;W_8;W_9)$ $\Rightarrow$ weight factor of error.

$(E_1;E_2;E_3;E_4;E_5;E_6;E_7;E_8;E_9)$ $\Rightarrow$ number of errors made (committed) by trainee which does not taken into account the after effect of the error. The seriousness of the after effect of the error is accounted by $(W_1;W_2;W_3;W_4;W_5;W_6;W_7;W_8;W_9)$ respectively.

$-(W_1E_1 + W_2E_2 + W_3E_3)$ $\Rightarrow$ represents errors detected by alarm printer (digital data) which could be categorised into critical, moderate and minor, that has the weight factor of $(W_1;W_2;W_3)$ respectively.

$-(W_4E_4 + W_5E_5 + W_6E_6)$ $\Rightarrow$ represents errors detected by event printer (analogue data) which could be categorised into critical, moderate and minor, that has the weight factor of $(W_4;W_5;W_6)$ respectively.

$-(W_7E_7 + W_8E_8 + W_9E_9)$ $\Rightarrow$ represents errors that could not be detected by a computerised system of that particular ERS but could easily be detected through assessor observation. These include telephone communication errors and lack of observation or attention paid to certain important parameters checking. It is also categorised into critical, moderate and minor, that have the weight factor of $(W_7;W_8;W_9)$ respectively.

$\{\sum WE\}$ $\Rightarrow$ is the sum of "total number of possible errors multiplied by the corresponding weight factor", that is, $(W_1E_{1T}+.....+W_9E_{9T})$ where, $(E_{1T}, E_{2T}....., E_{9T})$ are the total number of possible opportunities to make errors in the normal procedure.

$(W_BE_B)$ $\Rightarrow$ represents a bonus which have a weight factor of $(W_B)$ and number of bonuses of $(E_B)$. The bonus is imposed by the assessor if any of the weight factors $(W_1;W_2;W_3;W_4;W_5;W_6;W_7;W_8;W_9)$ were found inaccurate according to his justification during the assessment. For example, if there were three errors made which are subjected to a bonus, then the $(E_B)$ will be 3 with the $(W_B)$ depending on the assessor's judgement. However, the bonus should not be more than 10% of the total score of the possible error, that is "$(W_BE_B) < \{\sum WE\} \times 10\%$". Thereafter the assessor should, as soon as possible, propose to vary the respective inaccurate weight factor for future assessment.

The weight factor $(W_1;W_2;W_3;W_4;W_5;W_6;W_7;W_8;W_9)$ should be constantly revised to avoid the subjective bonus to creep in frequently causing inconsistency of assessment.

While revising the weight factors, a bell curve graph should be considered to determine the category of grading the $T_A$ (degree of achievement in %) as

$A\pm, B\pm, C\pm$, and the minimum passing mark. Within the education and training environment, our Ministry of Education has the aim of achieving "Zero Defect" that is no failure of student, in order not to waste resources. Therefore, the pass mark should be carefully studied. Besides, the weaker students should be focused for proper coaching.

Each ERS exercise with assessment needs a set of 9 weight factors that is $(W_1; W_2; W_3; W_4; W_5; W_6; W_7; W_8; W_9)$ to be scrutinised. If there were ten number of ERS exercises which need assessment to be done, then a total of ninety number of weight factors need to be scrutinised. Moreover, usually the number of the exercises is much more, therefore the weight factors should be considered from time to time in stages through a well organised committee. Also, in order to have a valid assessment the committee should decide on those weight factors and discuss any other matters concerning the assessment methodology. The committee may comprise a full range of experts such as ERS instructor/assessor, academic teaching staff, professional marine engineer, engine driver, the ERS maker, maritime administrator and staff from shipping companies. As such, the subjectivity of the weight factors could be decided by a group of people from various backgrounds. Consequently, an ideal average of the weight factors could be achieved easily to make the assessment valid.

For the Pre-Sea and Post-Sea Engineering Cadet ERS Programmes (ERS1 and ERS2), the author would say that the more objective type of assessment using the formula would be more suitable because of the following main reasons.

1. Those programmes are intended for preliminary knowledge to learn the skill from ERS. Therefore, a single serious error committed by a student does not deserve a grade of fail. As such, the formula should not give a fail result even though a single serious error is committed. This can be done easily by manipulating the corresponding weight factor which should be decided by the committee. If the

formula is not used, then the result will be very subjective according to the assessor which is not consistent.

2. With a different assessor it can still give a consistent result. This is very important because the ERS programme period is quite long, therefore it is flexible to have a different assessor but a fair assessment can still be maintained.
3. Since the criterion of the assessment is already decided by the committee, therefore assessors should have less of a tendency to perceive differing opinions and standards to cause conflict among them.
4. The quantitative value of degree of achievement could easily categorise the grading into various grades. Therefore, this will promote competition for the students to learn seriously.

Whereas, for the Engineer Officer ERS Programme (ERS3), the author would still say that the same type of assessment with the use of the formula would be appropriate. However, any single error made which may cause serious machinery damage, pollution or endanger safety of life and the ship should be categorised as a failure, because the main aim of this programme is to ensure the trainees have achieved the standard of competence as engineer officer at operational level as per STCW95. Therefore, the weight factors and/or passing mark should be adjusted accordingly by the committee to disqualify the student for such an error made. Another alternative suggestion is to add in another multiplication's constant as an additional penalty for $(W_1E_1,........,W_9E_9)$ without altering the value of $\{\sum WE\}$ in the $T_A$ equation. Hence, the alternative suggested formula is as follows.

$$T_A = \frac{\{\sum WE\} - (aW_1E_1 + bW_2E_2 + cW_3E_3) - (dW_4E_4 + eW_5E_5 + fW_6E_6)}{\{\sum WE\}} \rightarrow (continue)$$

$$(continue) \rightarrow \frac{-(gW_7E_7 + hW_8E_8 + iW_9E_9) + W_BE_B}{} \times 100\%$$

Where, $a, b, c, d, e, f, g, h$ *and* $i$ are the added multiplication constants without changing the value of $\{\sum WE\}$. The value of those multiplication constants needs to be decided by a committee.

As such, the $T_A$ achieved may range from 100% to negative % value. However, any negative % value of $T_A$ should be considered as 0 %. The negative % value achieved by some students can be used for comparison among those have failed.

Since ERS is the first experience to PUO as well as to the country's MET system, it is therefore suggested that for the first year after the ERS has been installed, the assessment used will be as a trial only. That is without accreditation of the assessment results to the MEDC curriculum and also not to be used for the assessment of engineer officers at the operational level during that first year utilisation period.

## 5.8. TEACHING METHODOLOGY.

Teaching method is believed to be the most important key towards the success of the students. The author believes that all the enrolled students are trainable. Educators/instructors are given the responsibility to train, mould and finally lead them into the proper channel. Such a situation will only exist if dedicated educators/instructors are aware and willing to improve their teaching method from time to time. However, the following teaching methodology proposed will basically refer to the training and assessment procedures of STCW95, Section A-I/12 pages 22-23.

### 5.8.1 METHOD OF CONDUCTING THE ERS1 AND ERS2 PROGRAMMES.

With reference to tables 5.1 and 5.2, ERS1 and ERS2 are conducted as follows. The Pre-sea and Post-sea Engineering Cadet ERS Programmes (ERS1 and ERS2) will be started with a daily briefing, aiming to give a lecture/discussion on important aspects of exercise together with its assessment strategy. The participants are briefed on the exercise objectives and tasks to play. They are also briefed clearly on the tasks and skills to be assessed; and on the tasks and performance criteria by which their competence will be determined as stipulated under STCW95 Section A-I/12 Part 2, item 8.3. In addition, diagrams such as blue print and photograph showing real ship board equipment and systems together with the printed previous record of the ERS programme should be used to reinforce the briefing.

The briefing will be followed by the instructor demonstration the ERS start-up and the performance of various operations as stipulated in the programme outline. The students will have to observe and note down the necessary important aspects. However, a lab sheet with detail procedures will be provided to the students in order to lead them through the programme.

After the instructor demonstration is completed, the students will have to carry out a few group exercises with all of them playing their own role. The exercises are repeated for the second time when an assessment is to be imposed on only one of the exercises. However, the students will not be informed which one of the exercises is under assessment. Thus, it could make them do all the exercises seriously for their own benefit. This is just a group assessment, the result of which may contribute 5% to each individual student's assessment. Since there are five days for each ERS programme, there will therefore be five such group assessments that will all together contribute 25% to each individual student's assessment. The individual student's assessment will be conducted within the trainee exercise period. If two students were to be assessed individually in a day starting from the second day of the programme, there will be eight students to be assessed for the remaining four days. The individual student's assessment outcome carries the weight of 75% to be added to the 25% of the group assessment. Thus it will form a complete individual assessment result.

Before the end of each day during the programme, a debriefing should be conducted to make all students realise their weaknesses and to ensure that the training objectives have been met. However, according to Mr. Stallwood and Findllay (1993), the debriefing should examine and comment on the positive aspects too, such as 'what went right instead of wrong' and 'what could be improved'. Thus it will further enhance the achieving of the training objectives.

### 5.8.2 METHOD OF CONDUCTING THE ERS3 PROGRAMME.

With reference to Table 5.3, ERS3 is conducted as follows. Similar to the ERS1 and ERS2, the ERS3 is started with a daily briefing. After the briefing, there will be a trainee exercise period for the students to practice . However, there will be no assessment conducted during this trainee exercise period. Instead, a separate trainee assessment period of three hours is allocated for the external assessor to assess each student individually. The purpose of this assessment is to determine whether the student is eligible to attend the fourth class COC oral examination which is after the MEDC.

This ERS3 programme has less reliance on the instructor. The students have to plan their own exercises to be carried basing on their previous ERS1 and ERS2 experience to practice the competent area as stipulated in Table A-III/1 of STCW95.

It is extremely important for those students who have deficiencies found in their sea training record books to practice those skills as well. Similarly, the ERS3 is also concluded with a debriefing session daily.

## 5.9 INSTRUCTOR/ASSESSOR QUALIFICATIONS AND TRAINING.

"Good teaching requires good teaching equipment. However, good teaching equipment requires an even better teacher!" (Cross, 1998). This statement implies that a good instructor is much more important even when you have a good teaching tool like the ERS. Therefore, in order to produce a good instructor, the qualifications and training of the instructor could be a very important factor for the success of ERS training.

From my supervisor, Professor Takeshi Nakazawa's point of view, an ERS and its instructors could be an equivalent comparison with a computer hardware and its software respectively. Therefore, simply if we have an expensive high capacity computer hardware without the software programme, the whole computer system just cannot function. Consequently, the ERS instructor is as equally important as the software of the computer system. Hence, it is useless to have a full task/mission operational ERS if the trained and qualified instructors are not available. This implies that it is very important for PUO to look into the matter at the earliest, that is before the ERS is installed because training of an instructor/assessor needs a considerable period of time. As such, the proposed ERS training programmes could be implemented immediately and effectively according to the STCW95 requirement in the future.

Under STCW95, Regulation I/6, Section A-I/6, Section B-I/6 and Section A-I/12, instructor/assessor qualifications and experience are specified. Generally, the qualifications and experience of the instructor/assessor is one of the convention requirements to achieve the quality standard as stipulated under Regulation I/8 of the convention. The ultimate aim is to ensure the instructor/assessor is properly certificated (holding relevant COC) and having sufficient experience in related matters. Consequently, for ERS training, marine engineers who hold a relevant COC should have additional ERS experience in order to recognise them as qualified instructors/assessors. As such, teaching staff in a MET institution who hold a relevant COC but without ERS experience should undergo an ERS instructor training programme. Such an ERS instructor training programme is important for the marine engineers to realise the differences of capability between ERS and the real machinery being used for training. In addition, the instructor should always behave as if the environment is real when conducting the training with the students. Therefore, the overall aim of utilising the ERS properly as a pedagogical training device can be achieved.

So far, all the teaching staff at PUO do not have ERS experience. Therefore, training is needed as per STCW95, Section A-I/6 which consists of three important elements, namely, guidance in instructional techniques to use the simulator, practical simulator operational experience, and practical assessment experience on the simulator. According to Professor Muirhead, P (1996, 263), those three important elements could be met, particularly for an institution with a newly installed simulator by, manufacturer's training programmes, learning on the job, understudying at another institution, and the use of IMO model courses such as 2.07 Engine Room Simulator and 6.09 Training Course for Instructors.

According to the author, the teaching staff of MED at PUO should be proactive to start now developing basic ERS instructional techniques through readings and the self studying of IMO model courses 2.07 Engine Room Simulator and 6.09 Training Course for Instructors which do not incur any cost. Eventually, if a budget is allocated and approved for the purchase of an ERS, a number of staff should be trained by the manufacturer's training programmes and/or understudying at another institution. An agreement should be made with the simulator supplier who is to be held responsible for the successful training of the instructors. In addition, the instructors/assessors should undergo as students being trained/assessed in a particular ERS programme, before they can be recognised as qualified instructors/assessors of that particular ERS programme.

According to Mr. Stallwood (1997), the outcome of workshop group 2, Mr. Stallwood commented, "This is to enable the instructors/assessors to be mentally capable of identifying the difficulties faced by the students during that particular ERS programme." Thus, the ERS could be optimised for use as a pedagogical training/assessment device. Since the proposed ERS programmes for the MEDC are only at the level of assistant engineer officer and engineer officer at operational level, therefore, the present staffs' availability, with four persons holding a second class COC and two persons holding a fourth class COC, is considered sufficient and qualified to be sent for further ERS instructor/assessor training.

In the general simulator instructor course conducted by Cross, S (1998) from Norcontrol, there are four important elements to be considered for success of ERS training programmes. They are the instructor, training programme, student and simulator equipment. These four elements are interdependent on each other. Therefore, each element should not be considered separately. Hopefully, with those STCW95 comprehensive needs being applied by a dedicated instructor/assessor, together with proper interaction among the four elements, success could be achieved.

# CHAPTER 6
# CONCLUSION AND RECOMMENDATIONS.

## 6.1 CONCLUSION.

Modern technology has influenced greatly engineering design and the operation of ships. This has changed the role of the marine engineer, which affects the marine engineer's education and training. The impact of modern technology on marine engineer training has resulted in the development of the engine room simulator to ensure effective training.

A Long time ago, MET institutions recognised the value of simulation systems as a training tool. Now, the STCW95 Convention and Code has officially promoted the use of simulators to enhance training. Moreover, under Regulation I/14 of STCW95, the management of the ship operator is responsible for the competency of seafarers serving on their ships. Therefore, one of the efficient and cost effective solutions to their problem is to use the engine room simulator to train their seafarers in MET institutions. Obviously, MET institutions and ship operators have a common interest in this regard. As such, if any acquisition of an engine room simulator is needed (especially in developing countries), it will be financially more viable now. Consequently, the engine room simulator for training of future marine engineers will be more common and popular in this competence and knowledge-intensive shipping industry.

When comparing the full-task/mission operational ERS with a training ship for training and retraining, the ERS training is much more feasible. This is due to the tremendous cost of the training ship, besides the need for high maintenance and the operational costs. Therefore, a training ship is not recommended to be used by most maritime institutions. However, some sea training experience is of course needed. It could be attained through shipping companies by sending trainees (cadets) to merchant ships for training. Unfortunately, nowadays, modern ships with UMS operation could not properly fulfil the training needs. As such, a full-task/mission operational ERS is the best compromise training equipment to enhance the modern merchant ships' training.

PUO is a pioneer institution which produces most of the marine engineer officers at operational level in Malaysia. Presently, shipping companies in Malaysia still operate on both UMS and non-UMS ship types, which need a wider range of training. Incorporation of an ERS training programme in the MEDC will no doubt help PUO to maintain the high standard of competence of the marine engineer, and cater for a wider range of marine engineer training in Malaysia. Besides, the new structure of the MEDC, with added ERS training and other programmes, will provide a good ground for the MEDC to be upgraded to a Bachelor's Degree. Concurrently, this will avoid the consequences of the MEDC merely producing machinery operators with insufficient academic knowledge and skill. As such, the MEDC graduates will be highly qualified with skill and academic knowledge to man/manage the shipping industry efficiently in the future. This is in line with the government's policy to promote Malaysia as a successful maritime nation.

## 6.2 RECOMMENDATIONS.

A committee should be set up to manage the project of ERS for the Marine Engineering Diploma Course (MEDC). The committee should be further divided into four sub-committees namely;

- Curriculum Committee,
- Survey Committee,
- Needs Justification Committee,
- Acquisition Committee.

Each of the sub-committees should consist of two academic staff who have good knowledge and experience in that particular area. An independent project leader will be selected to chair all the committee meetings. Therefore, the project has a task group of nine persons.

The responsibilities of the sub-committees should be as follows (most of which have already been discussed and analysed in this study) :

**Curriculum Committee**:

⇒ Propose ERS programmes and designing exercises.

⇒ Analyse teaching and assessment method to be used.

⇒ Consider instructors/assessors qualification and training.

⇒ Make recommendations for restructuring the MEDC curriculum.

⇒ Propose new schedule for MEDC structure.

**Survey Committee**:

⇒ Survey various types of existing ERSs.

⇒ Study the advantages and limitations of full-task/mission operational ERS from all simulator makers.

⇒ Identify a few suitable models of full-task/mission operational ERS from different makers. With reference to Appendix 2 and Appendix 3, draft technical specifications of the proposed full-task/mission operational ERS, by working together with the Needs Justification Committee.

**Needs Justification Committee**:

⇒ Justify the need for a full-task/mission operational ERS.

⇒ Analyse the cost effectiveness/benefits of using full-task/mission operational ERS.

⇒ Examine the impact of modern technology on training needs.

⇒ Identify the existing weaknesses of the MEDC. With reference to Appendix 2 and Appendix 3, draft technical specifications of the proposed full-task/mission operational ERS, by working together with the Survey Committee.

**Acquisition Committee:**

⇒ Examine methods of funding the proposed ERS project.

⇒ Determine the possible amount of funds that will be available from various sources.

⇒ Analyse and recommend terms and conditions for the sale and purchase agreement with special care to be taken regarding the training of instructors/assessors and after sale services.

**All Sub-committees** (the main committee):

⇒ Request approval of fundings.

⇒ Tender/Quote/Bid/Contract award/Agreement made and installation of the ERS.

⇒ Implement for trial run of the ERS programmes' exercises.

⇒ Improve the ERS programmes until success is achieved.

⇒ Complete the project.

(Appendix 1: Details of The Project's Implementation)

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# APPENDIX 1

# DETAILS OF THE PROJECT'S IMPLEMENTATION.

**Table A1.1: Details of the Project's Implementation.**

| No | Activity Description | OD day | D ES | D EF | D LS | D LF | F |
|---|---|---|---|---|---|---|---|
| 1 | Appointing of a project leader and eight sub-committee members. | 10 | 0 | 10 | 0 | 10 | 0 |
| 2 | Specify the task to be conducted by each sub-committee. | 10 | 10 | 20 | 10 | 20 | 0 |
| 3 | Proposal of ERS programmes. | 20 | 20 | 40 | 70 | 90 | 50 |
| 4 | Analyse teaching method to be used. | 20 | 40 | 60 | 90 | 110 | 50 |
| 5 | Analyse assessment method to be used. | 20 | 40 | 60 | 90 | 110 | 50 |
| 6 | Consider instructors/assessors qualification and training. | 20 | 60 | 80 | 110 | 130 | 50 |
| 7 | Make recommendation for restructuring of the curriculum. | 40 | 80 | 120 | 130 | 170 | 50 |
| 8 | Proposed schedule for MEDC. | 10 | 120 | 130 | 170 | 180 | 50 |
| 9 | Write an outcome report by the Curriculum Committee. | 20 | 130 | 150 | 180 | 200 | 50 |
| 10 | Justification of the need for a simulator. | 20 | 20 | 40 | 130 | 150 | 110 |
| 11 | Analyse the cost effectiveness/benefits of the use of simulators. | 40 | 20 | 60 | 110 | 150 | 90 |
| 12 | Examine the impact of modern technology on training needs. | 20 | 60 | 80 | 150 | 170 | 90 |
| 13 | Identify the existing weaknesses in MEDC. | 20 | 80 | 100 | 170 | 190 | 90 |
| 14 | Write an outcome report by the Needs' Justification Committee. | 10 | 100 | 110 | 190 | 200 | 90 |
| 15 | Survey various types of the existing ERS. | 90 | 20 | 110 | 20 | 110 | 0 |
| 16 | Study the advantages and limitations | 60 | 110 | 170 | 110 | 170 | 0 |

| No | Activity Description | OD | D | | | | F |
|---|---|---|---|---|---|---|---|
| | | day | ES | EF | LS | LF | |
| | of each type of simulator. | | | | | | |
| 17 | Identify a suitable type of simulator to be used. | 20 | 170 | 190 | 170 | 190 | 0 |
| 18 | Write an outcome report by the Survey Committee. | 10 | 190 | 200 | 190 | 200 | 0 |
| 19 | Examine methods of funding for the proposed simulator. | 20 | 20 | 40 | 80 | 100 | 60 |
| 20 | Determine the possible amount of fund that will be available. | 20 | 40 | 60 | 150 | 170 | 110 |
| 21 | Analyse and recommend terms and conditions for the sale and purchase agreement. | 60 | 40 | 100 | 100 | 160 | 60 |
| 22 | Write an outcome report by the Purchasing Committee. | 40 | 100 | 140 | 160 | 200 | 60 |
| 23 | Finalise all the outcome reports. | 40 | 200 | 240 | 200 | 240 | 0 |
| 24 | Requesting/waiting for approval of fund. | 60 | 240 | 300 | 240 | 300 | 0 |
| 25 | Tendering/Quotation/Bidding/ Contract award/agreement made and installation of ERS. | 70 | 300 | 370 | 300 | 370 | 0 |
| 26 | Implementation for trial run of the Engine Room Simulator Programmes. | 30 | 370 | 400 | 370 | 400 | 0 |
| 27 | Continuous improvement of the ERS Programmes. | 50 | 130 | 180 | 320 | 370 | 190 |
| | | | | | | | |

**Keys:** OD-original duration (days) ; D-date ; ES-early start ; EF-early finish ; LS-late start ; LF-late finish ; F-Floats/slacks.

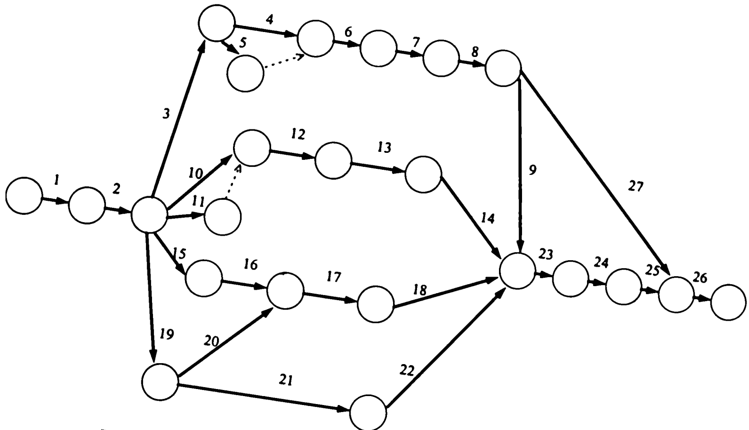


**Figure A1.1: Arrow diagram for the Details of the Project's Implementation.**

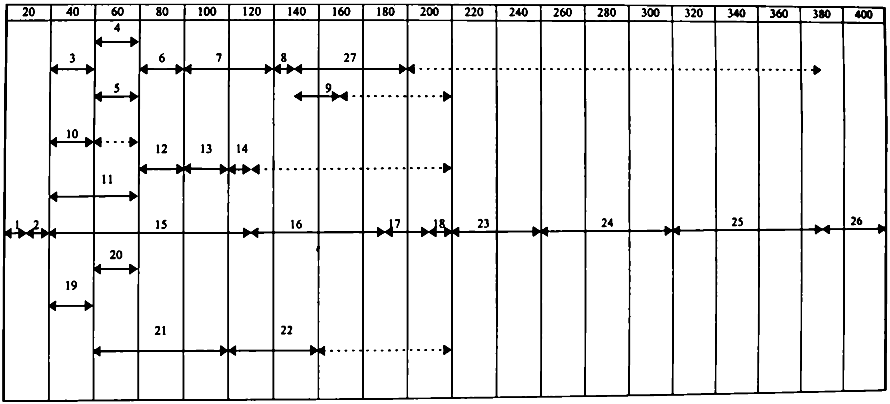


**Figure A1.2: Time scaled diagram (days) for the Details of the Project's Implementation.**

## APPENDIX 2

## TYPICAL FULL-TASK/MISSION OPERATIONAL ENGINE ROOM SIMULATOR BY MITSUI ENGINEERING & SHIPBUILDING CO., LTD, JAPAN.

In 1975, Mitsui Engineering & Shipbuilding Co., Ltd. (MES) had made Main Engine Remote Control type engine room simulators mainly for the use in training ships. One of the main aim was to train seafarers who would be engaged in the delivery of new UMS Ships.

Since STCW78 came into force in 1984, MES (play the role of maker) had joined effort with; Prof. Takashi Nakamura, Prof. Kenji Ikenishi both from Marine Technical college, Japan; Ishikawajima-Harima Heavy Industry (IHI); and Terasaki Electric Company to further develop a full-task/mission operational type engine room simulator. This is to cope with the demand of Flag Of Convenience (FOC) Ships that require an improve training facility for seafarers of mixed nationality. Besides, it is for the Japanese Government to assist developing countries to fulfil the need of STCW78 by establishing a system of certifying seafarers and improving training facilities. Therefore, the full-task/mission operational engine room simulator is installed for the following maritime institutions:

Marine Technical College, Japan, during the year 1985;
Follow by developing countries,
Pakistan Marine Academy, Pakistan, during the year 1989;

Jakarta Merchant Marine Academy, Indonesia, during the year 1991.

## SIMULATED MODEL.

Those full-task/mission operational engine room simulators dynamically simulate a high speed modernised container vessel with a slow speed turbocharged main diesel engine are as the following specifications.

### *SHIP SPECIFICATIONS.*

| | |
|---|---|
| Type: | High speed container ship capable of loading some refrigerated containers. |
| Classification: | NK, NS*, 'Container Carrier', MNS*, M0.B. |
| Length between perpendicular: | 230 m. |
| Dead-weight: | 38,500 MT. |
| Ship's speed: | 26.5 Knots. |
| Number of containers: | 2,840 TEU (Refrigerated containers 252 TEU) |

### *MAIN DIESEL ENGINE SPECIFICATIONS.*

**EITHER,**

| | |
|---|---|
| Type: | Sulzer 8RLB90 diesel engine. |
| Maximum Continuous Rating: | 22,210 kW (30,200 PS) at 100 rpm. |
| Normal Continuous Rating: | 18,880 kW (25,670 PS) at 94.7 rpm. |
| Number of cylinder: | 8. |
| Cylinder bore: | 900 mm. |
| Piston stroke: | 1900 mm. |

| | |
|---|---|
| Auxiliaries on engine: | Two turbo-chargers, one air cooler, one auxiliary blower and one turning gear. |

OR,

| | |
|---|---|
| Type: | B&W 7K90MC diesel engine. |
| Maximum Continuous Rating: | 24,050 kW (32,700 PS) at 86 rpm. |
| Normal Continuous Rating: | 21,650 kW (29,430 PS) at 83 rpm. |
| Number of cylinder: | 7. |
| Cylinder bore: | 900 mm. |
| Piston stroke: | 2500 mm. |
| Auxiliaries on engine: | Two turbo-chargers, two air coolers, two auxiliary blowers and one turning gear. |

## *PROPELLER AND STERN TUBE BEARING SPECIFICATIONS.*

| | |
|---|---|
| Propeller: | One 5-blade fixed propeller with diameter of 7.9 m. |
| Stern tube bearing: | One oil bath type bearing with compact sealing device. |

## *STEAM GENERATING SYSTEM SPECIFICATIONS.*

One package oil fired type auxiliary boiler with;

| | |
|---|---|
| Maximum steam pressure: | 9 kg/cm$^2$ (saturated steam). |
| Maximum evaporation rate: | 14.5 tonne/hour. |

One forced circulation type exhaust gas economiser with;

| | |
|---|---|
| Superheated steam: | 215°C x 6.5 kg/cm$^2$. |
| Saturated steam: | 7.0 kg/cm$^2$. |

## *ELECTRIC GENERATING SYSTEM SPECIFICATIONS.*

One turbo-generator: 1500 kW at 1800 rpm.

Two diesel generators: 1350 x 2 kW at 720 rpm.

One emergency generator: 200 kW at 720 rpm.

(All the generators are of 450V, 60 Hz and power factor of 0.8)

## THE CONFIGURATION OF THE HARDWARE.

The simulator consist of four main components. They are namely:

i) a large-sized graphic panel,

ii) a replica engine control console,

iii) an instructor console, and

iv) a central processing unit (CPU).

These four main components are arranged as in the following Figure A2.1: Layout of full-task/mission operational engine room simulator by MES.

### *THE LARGE-SIZED GRAPHIC PANEL.*

This panel graphically represents the machinery and equipment in the engine room. Full consideration has been given to the arrangement of equipment symbols on the panel to facilitate understanding of the various systems in the engine room. In addition, there are all together 64 numbers of pump start/stop buttons and 577 numbers of valve open/close buttons on the graphic panel that faithfully simulate the real engine room system.

The graphic panel is divided into five sections according to the following machinery groupings.

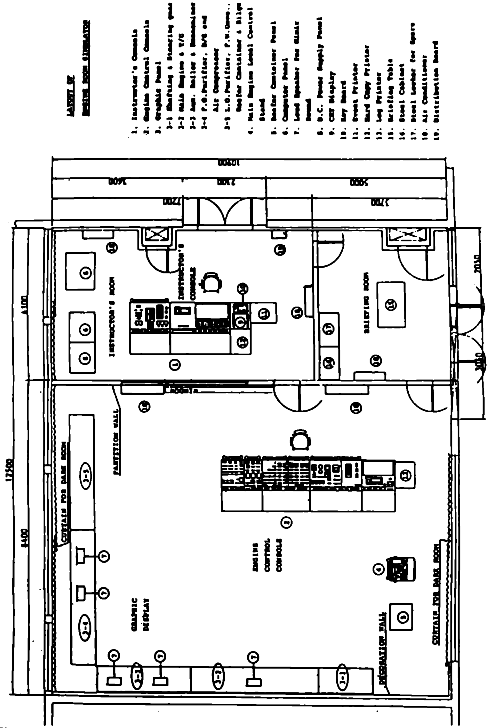


**Figure A2.1: Layout of full-task/mission operational engine room simulator.**

**Source: Full-task/mission operational ERS Manual, MES.**

*MAIN DIESEL ENGINE AND TURBO-GENERATOR GROUP.*

This panel section represents the main diesel engine, turbo-generator and their related equipment. The equipment symbols arranged in this section include the main engine, turbo-generator and their auxiliaries such as lubricating oil pumps, cooling fresh water pumps, main and auxiliary cooling sea water pumps, fuel oil booster pumps, vacuum pumps, condensate pumps, heat exchangers and tanks. They are all connected by a representation of piping systems necessary for normal functioning of equipment.

*SHAFTING AND STEERING GEAR GROUP.*

This panel sections represents the stern tube lubricating oil (L.O.) and steering gear systems. In the stern tube lubricating oil system symbols are used to represent the stern tube L.O pumps, stern tube L.O. gravity tanks, stern tube sealing oil tanks, and a piping system for the interconnection of the equipment. In the steering gear system the hydraulic oil pumps, hydraulic tanks and cylinder rams are also represented by symbols and also interconnected with a representation of a piping system.

*GENERATOR GROUP.*

This panel section represents the diesel generators, air compressors and related equipment. The equipment symbols arranged in this section include the diesel generators, main and auxiliary air compressors, sea water service pumps, and heat exchangers. They are all connected by a representation of piping systems necessary for normal functioning of equipment.

*AUXILIARY BOILER GROUP.*

This panel section represents the auxiliary boiler, exhaust gas economiser and related equipment. The equipment symbols arranged in this section include the auxiliary boiler, exhaust gas economiser and their auxiliaries such as boiler's main/pilot fuel oil pumps, boiler feed water pumps, boiler water circulating pumps, force draft fans, heat exchangers and tanks. They are all connected by a representation of piping system necessary for normal functioning of equipment.

*FUEL OIL TRANSFER GROUP.*

This panel section represents the fuel oil transfer pumps, fuel oil purifiers and their related equipment. The equipment symbols arranged in this section include the main and auxiliary fuel oil transfer pumps, heavy fuel oil purifier, diesel oil purifier, heavy fuel oil tank and diesel oil tank. They are all connected by a representation of piping systems for normal functioning of the equipment.

*LUBRICATING OIL TRANSFER GROUP.*

This panel section represents the lubricating oil transfer pump, lubricating oil purifier and their related equipment. The equipment symbols arranged in this section include the lubricating oil transfer pump, lubricating oil purifier, storage tanks and settling tanks. They are all connected by a representation of piping system necessary for normal functioning of equipment.

*FRESH WATER AND REFRIGERATED CONTAINER GROUP.*

This panel section represents the fresh water, drinking water and refrigerated container cooling fresh water systems. The equipment symbols arranged in this section include the fresh water pumps, drinking water pump, refrigerated container cooling fresh water pumps and various tanks. They are all connected by a representation of piping systems necessary for normal functioning of equipment.

*BILGE TREATMENT GROUP.*

This panel section represents the treatment system in the engine room. The equipment symbols arranged in this section include the fire and general service pump, oily water separator and tanks. They are all connected by a representation of piping system necessary for normal functioning of equipment.

*VALVES GROUP ARRANGED ON GRAPHIC PANEL.*

The valves arranged on the graphic panel are as follows:

Ordinary valves (including drain traps);

These valves can be open or shut by trainees on the graphic panel. The corresponding indicator lights are lit when the valves are open.

Safety valves;

The safety valves cannot be operated manually by trainees on the graphic panel. They are operated when the corresponding systems have achieved the pop pressures. The associated indicator lights are lit when they are operated. The safety valves include the auxiliary boiler safety valves, exhaust gas economiser superheater safety valves, and air reservoir safety valves.

Motor and solenoid valves;

Motor valves can be controlled while solenoid valves cannot be controlled on the graphic panel. Their open-shut control is done with the associated control switches on the graphic panel or engine control console. The associated indicator lights are lit when they are open.

Various regulating valves;

The regulating valves, such as temperature, pressure, and level regulating valves are not operative on the graphic panel. They are operated by varying the supply pressure of the control air.

*THE REPLICA ENGINE CONTROL CONSOLE.*

The control console is a full-size actual console used in the engine control room of the model ship. The aim is to make the training environment more real and allow the trainees to have hands-on experience on a real control console. The engine control console consists of the following sections.

*MAIN DIESEL ENGINE MANOEUVRING SECTION.*

This section has a remote manoeuvring handle, a sub engine telegraph, main engine control position change over switch, a remote control switch for main engine starting air, an automatic control switch for main engine scavenging air pressure control, remote control switches for main engine fuel oil change over, instruments for remote monitoring of main engine running conditions, and a telephone for communication with the wheelhouse.

*THE AUXILIARY BOILER CONTROL SECTION.*

This section has an automatic combustion controller (ACC), a feed water controller, change over switch for a superheater steam valve on the exhaust gas economiser, a soot blower remote control switch, and instruments and indicator lights for remote monitoring of the auxiliary boiler.

*ELECTRIC GENERATOR SYSTEM, SWITCHBOARD AND GROUP STARTER PANEL SECTION.*

In an actual ship, the switchboard and group starter panel are not part of the engine control console, but are independent units separately installed. However, they are included here as part of the engine control console in order to facilitate better training.

*LOGGER AND ALARM SYSTEM SECTION.*

This section is fitted with an automatic alarm system and associated logger equipment including an alarm printer and an engine log printer.

*THE INSTRUCTOR CONSOLE.*

The instructor console is divided into following two main sections.

*WHEELHOUSE CONTROL SECTION.*

This section has a remote main diesel engine manoeuvring handle (also serve as the engine telegraph), a sub engine telegraph, a main engine control position change over switch, remote control switches for main engine starting root valves, a program bypass switch, instruments and indicator lights for monitoring of main engine running conditions, and a telephone set for communication with the engine control room.

*SIMULATOR OPERATION SECTION.*

This section is fitted with a 'start or stop' simulator control switch, an initial condition setting panel, an abnormal condition setting panel, and a printer.

The initial condition setting panel has 8 kinds of initial condition setting such as sea water temperatures, sea conditions and ship's drafts; and 7 kinds of operation modes from the dead ship to full away and back to finished with engine.

The abnormal condition setting panel has about 500 kinds of abnormal operation settings provided for the instructor to set faults during training. The abnormal operation caused by the instructor can be restored back to normal operating condition if the trainee has taken appropriate rectification.

*A CENTRAL PROCESSING UNIT (CPU).*

The central processing unit consists of 4 main computers and other computers for the control of INPUT/OUTPUT (I/O), Cathode Ray Tube (CRT), and Local Area Network (LAN). There are two main computers installed in a CPU panel, and the other two are installed in the engine control console and instructor console respectively. The four main computers are linked with a fibre optic cable unit.

The concept of the information processing system is shown in Figure A2.2, and it's functions are as the following.

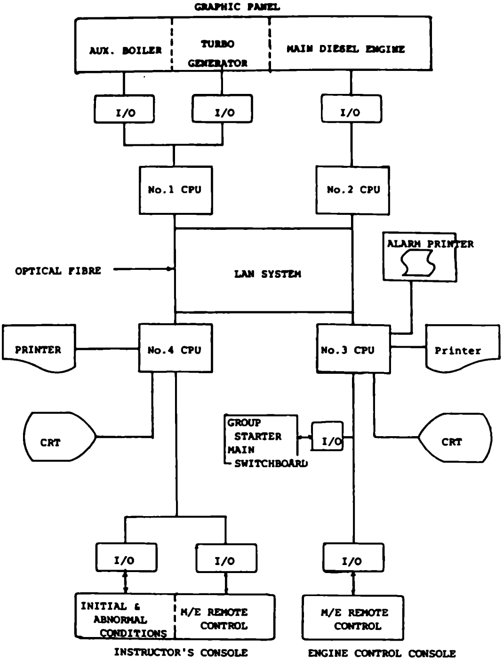


**Figure A2.2: Concept of Information Processing System.**

**Source: Full-task/mission operational ERS Manual, MES.**

*THE FOUR MAIN COMPUTERS.*

These main computers use 16 bit microprocessor (NEC, D70116, Intel 8086 and Intel 8087 for computing), and have 640k byte of ROM and 256k byte of RAM.

Main computer number 1 has the function of checking the conditions of all pipe lines and computing the characteristics of the main diesel engine.

Main computer number 2 has the function of checking and computing of the operating conditions for the main engine, boiler and economiser.

Main computer number 3 has the function of computing and controlling the indications and alarms for the main engine control console.

Main computer number 4 has the function of computing and controlling the indications and alarms for the instructor console.

*THE COMPUTER FOR INPUT/OUTPUT (I/O COMPUTER).*

I/O computer has 8 processors (8 bit, Motorola 6809), which has the functions of controlling 750 switches, 700 lights and 130 gauges on the graphic panel, engine control console and instructor console.

*THE LOCAL AREA NETWORK (LAN).*

In order to ensure efficient data transmission among the computers, LAN system is being used for this simulator. The specifications of the LAN system are as the following:

| | |
|---|---|
| Data Rate: | 1Mbps. |
| Media: | 2 core Optical Fibre Cable. |
| Topology: | Duplex Loop. |
| Transmit Distance: | 32 km. (max.) |
| Countermeasure for Obstruction: | By-pass function, Loopback function. |
| Method of Transmission Control: | High Level Data Link Control. |
| Access Method: | Token passing. |

*THE MIMIC SOUND GENERATOR.*

This simulator has a mimic sound generator to make the training environment as close as possible to the real engine room. The sound generator has its own computer for reproduction of various sounds according to the operating conditions of the main engine, electric generators and air compressors. The sound generator able to produce 39 kinds of sounds over four loudspeakers.

# APPENDIX 3

# TYPICAL FULL-TASK/MISSION OPERATIONAL ENGINE ROOM SIMULATOR (PPT2OOO-SULZER 6RLB66) BY KONGSBERG NORCONTROL SYSTEMS, HORTEN, NORWAY.

## PROPULSION PLANT TRAINER 2000 (PPT-2000).

PPT-2000 is the latest series of engine room simulator produced by Norcontrol, Norway. The PPT-2000 series has three configuration options. They are full-task/mission operational version, workstation version and a combination of both versions.

With more than thirty years of simulation experience, today, Norcontrol is one of the world's leading supplier of marine simulators. A wide range of simulated ships with their propulsion plants is available from the PPT-2000 series. However, only one typical model of ship with its propulsion plant and of operational version will be elaborated.

## SIMULATED MODEL.

The simulated model is a modern crude oil carrier with a slow speed, large bore and turbocharged main diesel engine as the following specifications.

## *SHIP SPECIFICATIONS.*

| | |
|---|---|
| Type: | Crude oil carrier. |
| Length overall: | 200.00 m. |
| Length between perpendicular: | 191.00 m. |
| Breadth moulded: | 18.40 m. |
| Summer draught: | 13.00 m. |
| Dead-weight: | 80,000 tons. |
| Ship's speed: | 15 knots. |

## *MAIN DIESEL ENGINE SPECIFICATIONS.*

| | |
|---|---|
| Type: | Sulzer 6RLB66 diesel engine. |
| Cylinder bore: | 660 mm. |
| Piston stroke: | 1,400 mm. |
| Number of cylinders: | 6. |
| Number of air coolers: | 2. |
| Number of turbochargers: | 2. |
| Continuous service rating: | 7,848 kW (10,670 PS). |
| Corresponding engine speed: | 131 rpm. |
| Corresponding engine load: | 81.7 % |
| Scavenge air pressure: | 1.57 bar. |
| Turbocharger turbine speed: | 13,850 rpm. |
| Specific fuel oil consumption: | 182 g/kWh. |
| Auxiliaries on engine: | One auxiliary blower and one turning gear. |

## *PROPELLER, SHAFT, STERN TUBE BEARING LUBRICATING AND STEERING GEAR SYSTEMS.*

The models of the propeller system consists of a fixed and a controllable pitch (CP.) propeller systems. Both of the systems are designed to the maximum continuous rating of the main engine with a service speed in accordance with the actual ship model. The CP. propeller system has a hydraulic oil system for controlling the propeller pitch.

The shaft system consists of intermediate and propeller shafts with oil lubricated bearings.

The stern tube bearing lubricating system consists of header tank with necessary piping system.

The steering gear system consists of two hydraulic pumps. The rudder moving rate can be controlled by varying the flow rate of the pumps.

## *ELECTRIC POWER DISTRIBUTION SYSTEM SPECIFICATIONS.*

The power distribution model is designed as a standard three phase, three wire, 450 volts and 60 Hz system, and with transformers for lighting system.

The electric power plants are modelled as a plant comprising:

- Two diesel generators.
- One turbogenerator.
- One shaft generator.
- One emergency generator.

- Two transformers for lighting.

The power distribution system consists of an emergency switchboard and a main switch board. The emergency switchboard has one emergency bus-bar. The main switchboard internally divided into four bus-bars. The consumers are group to these respective bus-bars as follows:

Emergency switchboard with emergency bus-bar supplying:

- Starting air compressor.
- Heavy oil and diesel oil supply pumps.
- Servo pump for controllable pitch propeller.
- Steering gear pump.
- Emergency fire pump.
- Bilge pump.

Main switchboard with four bus-bars namely:

- Main Bus-Bar 1, supplying all essential consumers.
- Main Bus-Bar 2, supplying bow thruster and deck cranes.
- Non-Essential Consumer Bus-Bar.
- Lighting Bus-Bar.

The Main Bus-Bar 1 normally is supplied by two diesel generators and one turbogenerator. The shaft generator normally supply the Main Bus-Bar 2.

The Main Bus-Bar 2 can be manually disconnected from Main Bus-Bar 1. Therefore, allowing the shaft generator to isolate from the rest of the electric consumers but only supplying the bow thruster and deck cranes. As such, the rest of the electric consumers will not be interrupted by the operations of bow thruster and deck cranes.

The Non-Essential Consumer Bus-Bar will be tripped in accordance with the requirements made by classification societies.

## *AUXILIARY SYSTEMS.*

Other auxiliary engine room systems are as the following:

- Steam supplying system consists of one oil fired boiler and an exhaust gas economiser.
- Fuel oil system consists of a Heavy Oil (H.O.) and Diesel Oil (D.O.) systems.
- Lubricating oil (L.O.) system consists of main engine L.O., cam shaft L.O and cylinder L.O. systems.
- Purifier system consists of three different systems; an H.O. transfer with H.O. purifier system; a D.O. transfer with D.O. purifier system; and an L.O. transfer with L.O purifier system.
- Fresh water cooling system consists of a low temperature system and a high temperature system. Both of the systems are cooled by a sea water cooling system.
- Fire and deck wash system consists two fire pumps and one emergency fire pump that receive power supply from main switchboard and emergency switchboard respectively.
- Bilge and sludge system consists of two bilge pumps, an oily water separator, bilge wells, a sludge tank, and an incinerator.
- Compressed air system consists of a starting air system, a control air system and a manoeuvring control air system for the main engine.
- Main engine remote control system.
- Alarm monitoring system.

## THE CONFIGURATION OF THE HARDWARE.

The simulator is arranged over three separate rooms, namely:

i) engine room,

ii) engine control room, and

iii) instructor room.

A layout of the simulator is as shown in Figure A3.1. Each room is equipped with various facilities as the next page.

### *ENGINE ROOM FACILITIES.*

The facilities available in the engine room are:

i) local operating panels (wall model) or consoles (floor model),

ii) a mimic panel,

iii) a local operation station console,

iv) a real proportional, integral and derivative (PID) controller, and

v) loudspeakers for the sound system.

### *THE LOCAL OPERATING PANELS OR CONSOLES.*

These panels represent the various engine room systems found onboard a typical ship. Each panel is furnished with start/stop and open/closed pushbuttons with their status lights. These panels also have various pressure, temperature, current, voltage and etc. indicators.

Features for resetting of trip and simulating repair of malfunction components are included as well. These panels can be exchanged for a mimic panel.

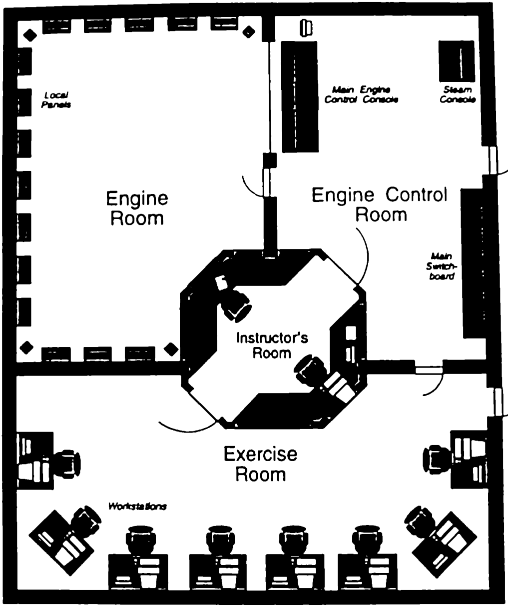


**Figure A3.1: Layout of full-task/mission operational Propulsion Plant Trainer 2000 by Norcontrol.**

**Source: Propulsion Plant Training (PPT 2000) Manual, Norcontrol.**

*THE MIMIC PANEL.*

The interactive mimic panel represents the sub-systems found onboard a typical ship. The panel is furnished with various pushbuttons, status lights and pressures/temperatures indicators. The mimic panel can be exchanged with for local operating panels.

*THE LOCAL OPERATION STATION CONSOLE.*

The local operation station console consists of colourgraphic cathode ray tube (CRT) display. The available information from the CRT display can be mimic pages or parameter readings. This station is to complement the mimic panel or local operating panels. The CRT display is set by the instructor for the use of malfunction corrections.

*THE REAL PID CONTROLLER.*

This controller should be able to control selectable systems in the software model. When the real PID controller is connected to the simulator, it will replace and by-passed the controller in the selected system of the software.

*THE LOUDSPEAKERS FOR THE SOUND SYSTEM.*

Four loudspeakers are located in the engine room to reproduce the simulated sounds from the main engine, turbochargers, diesel generators, pumps, blowers, air compressors and etc.

## *ENGINE CONTROL ROOM FACILITIES.*

The engine control room is fitted with equipment similar to that found onboard the simulated ship. There are four separately located items in the engine control room. They are:

i) control room console,

ii) main switchboard, and

iii) steam control console.

## *THE CONTROL ROOM CONSOLE.*

The control room console is based on Norcontrol's broad experience with ship instrumentation and monitoring systems, and will closely resemble real shipboard equipment.

The console comprises the following three sections:

- Main engine remote control (AutoChief).
- Alarm monitoring (DataChief).
- Pump / compressor / electrical control (PowerChief).

The main engine remote control console is one section of the control room console and is based on the Norcontrol's "AutoChief". This section includes equipment for operation of the main engine with, indication of the engine status and measured values of the main engine subsystems.

The alarm monitoring console is one section of the control room console. This section is called "DataChief", and consists of a high resolution graphical workstation with a dedicated operational keyboard. The high resolution graphical workstation is used for alarm handling. A printer acts as a log is also provided.

The pump, compressor and electrical generation control console is one of the control room console. This section is based on Norcontrol's PowerChief which can control the operation of pumps, compressors and electrical generators manually or automatically.

*THE MAIN SWITCHBOARD.*

The main switchboard is a replica of a real switchboard. The main switchboard consists of all controls and indicators usually available on a real switchboard. There are two loudspeakers installed inside the main switchboard to reproduce the simulated sound of switchboard operation.

The main switchboard includes the following sections:

- Diesel generator number 1 & 2.
- Synchronising.
- Turbogenerator.
- Shaft generator.
- Emergency generator.
- Miscellaneous.

The diesel generator number 1 & 2 section comprises two identical diesel generators, modelled as high/medium speed engines with all vital sub-systems such as constant speed governor, cooling water, lubricating oil, starting air, turbocharger, air cooler and fuel oil.

The synchronising section consists of a double-volt meter, a double-frequency meter and a synchro-indicator/synchroscope. A selector switch is available for switching over to read the differences of supply voltages and frequencies between two generators during synchronising process. A mega-ohm meter is also available to detect and indicate if any earth fault on the main bus-bars. A shore connecting device is provided to monitor the phase sequence and cross-coupling of the leads (if needed) before the shore connection is made.

The turbogenerator is modelled with a gland seal system, drain valves, constant speed governor, lubricating oil system and steam condenser with cooling water system. The turbogenerator is protected by alarms, automatic stop and shut-downs according to the classification societies requirements.

The shaft generator operation is depending on the main engine operation. A prerequisite for shaft generator operation is that the main engine remote control is in the shaft generator mode.

The emergency generator section has a volt meter and an ampere meter. During black-out the emergency generator starts and connects automatically to only emergency bus-bar that supply selected electrical consumers. As soon as one of the main generator is connected back on the main bus-bar, the emergency generator will be stopped.

The miscellaneous section contains power consumption indicators for sea water pumps, low temperature fresh water pumps, high temperature fresh water pumps and main lubrication oil pumps. These pumps can be connected to a static converter for speed control.

*THE STEAM CONTROL CONSOLE.*

The steam control console includes control and readings of the condenser, the steam generator, the oil fired boiler and the exhaust gas boiler.

*INSTRUCTOR ROOM FACILITIES.*

The instructor room includes instructor workstation, printers, sound amplifier and communication system.

*INSTRUCTOR WORKSTATION.*

The instructor workstation comprises a main computer, CRT monitor, trackball mouse and an operational keyboard with 'Training and Evaluation Control' (TEC-2000).

From the instructor workstation, the instructor shall be able to perform simulation control, general system communication, entering faults, setting of operational and ambient conditions, evaluate the training performance, and replay phases of the training task.

The instructor functions are categorised into primary and secondary functions as the following.

The primary functions are:

- Start of simulator.
- Stop simulator.
- Select scenario.
- Run simulator.

- Freeze simulator.

The secondary functions are:

- Change scenario.
- Set alphanumeric pages of variables, malfunctions and alarms.
- Operating conditions.
- Take snapshots.
- Replay.
- Simulation speed (relative real time).
- Sound control.
- Inhibit control of alarm systems.
- Access control of input.
- Set-up control and read access for the trainees.
- Perform administrative tasks concerning the operation of the simulator.

The instructor has full control of the simulator and training session through the above listed functions. Whenever he likes, he can change the environment during a scenario and evaluate the trainee's respond to the situation.

The instructor's keyboard TEC-2000 is divided into sections with dedicated keys for the operational functions and the various controls. Some typical example are:

(Typical external conditions control by instructor)

- Deck and accommodation steam, (Steam consumption in variable steps)
- Deck air, (service air consumption)
- Ice conditions, (variable resistance)
- Heavy electric power, (power consumption)
- Ship load, (variable in % of full load)

(Typical simulator dynamics control by instructor)

| | |
|---|---|
| • Emergency run, | (fixed settings) |
| • Freeze the simulator, | (process stop) |
| • Fixed process, | (compressed air system, steam & temperature) |
| • Level response, | (variable settings) |
| • Fast ship, | (variable settings) |
| • Fast process, | (variable settings) |

The instructor can make initial conditions and scenarios before the training session. Also, the instructor can change the scenario during the training in progress.

*PRINTERS.*

A log printer is provided for the instructor to received information about all attempts in fault resetting done by the trainees. The printer also being used for logging of events and alarms. Each of these logs can be selected by the instructor. If more than one is selected, all the requested events are printed out in a chronological order.

A colour printers is provided for the instructor to print hardcopies of the various mimic diagrams displayed on the monitor.

*SOUND AMPLIFIER.*

The sound amplifier is used to produce and amplify simulated machinery sounds. The noise level in the engine room and engine control room can be controlled by the instructor in the range from no noise up to a realistic noise level.

*COMMUNICATION SYSTEM.*

The engine control room, engine room and instructor room are connected with internal telephone system. The instructor workstation shall with this facility also be able to act as a wheelhouse.

## COMPUTER SYSTEM.

The main computer in the instructor workstation together with other computing units which are situated in the simulator's local panels and consoles are linked together by Ethernet which is a LAN system. In this way, the main computer will act as a server for all other computers. Furthermore, the LAN system enables the computers to share the disk systems using Network File System (NFS). Therefore, a computing task may be routed to any computer having spare capacity.

Future extensions will easily be integrated into the existing system because of the standardised LAN communication system. Therefore, an operational version engine room simulator can be easily upgraded to become a combined version by simply extending student workstations through parallel connection to the LAN system.